University of the State of New York

NEW YORK STATE MUSEUM

Fifty-first Annual Report

OF THE

REGENTS

1897

VOL. 1

REPORTS OF THE DIRECTOR, STATE BOTANIST AND STATE ENTOMOLOGIST

TRANSMITTED TO THE LEGISLATURE JANUARY 5, 1898

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UNIVERSITY OF THE STATE OF NEW YORK

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No. 48

IN SENATE

January 5, 1898

51st ANNUAL REPORT

OF THE

NEW YORK STATE MUSEUM

To the Legislature of the State of New York

I have the honor to submit herewith pursuant to law, as the 51st annual report of the University on the New York state museum, the reports of the director of the museum, of the state geologist and paleontologist, of the state botanist and of the state entomologist, with appendices.

ANSON JUDD UPSON
Chancellor

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Vol. 1

NEW YORK STATE MUSEUM

REPORT OF THE DIRECTOR

for the fiscal year ending 30 Sep. 1897

The honorable, the regents of the University of the State of New York

GENTLEMEN: During the past year the museum has been improved in its general appearance and the collections have been increased to a very satisfactory degree considering the limited means available.

Since 1893 the work of the director of the museum and of the state entomologist and state botanist has been seriously affected by the abrupt and unexpected reduction of the museum appropriation under the control of the regents, from $19,200 to $6720. Although a considerable portion of the original sum had been devoted to the salary and expenses of the state geologist, the reduced amount was insufficient to meet the salary list alone of the three officers previously mentioned. In this financial condition and with no encouragement for prospective increase in funds, it seemed necessary to preserve the existence of the museum by suspending expenditure wherever possible and by a careful husbanding of unexpended balances to tide over a very critical period. In the three departments mentioned the work was therefore limited, so far as possible, to that which could be done with small expense.

Among the important lines of work which could be accomplished in the museum without other expense than that for salaries, was the rearrangement of the geological collections which, owing to the progress of geological science, had become somewhat antiquated.

The paleontological collection having been rearranged during 1894-95, it was decided to prepare a synoptical geologic collection which should exhibit type-specimens from the various formations

and counties of the state arranged and labeled in such a manner as to form a standard collection of the rocks of New York which should be intelligible not only to the specialist, but to the school teacher and the beginner in geology. There being nowhere else in the world a complete collection of New York rocks, and New York being the mother state in geologic nomenclature, it seemed that nothing more important could be done. This task was by no means a light one. It involved the examination of all specimens which had been gathered since the beginning of the natural history survey in 1836 and the verification of the records on several thousand old labels with a view to the elimination of errors which were often found. Frequently an imperfect specimen needed to be replaced by better material and to do this with economy, has been a slow process, as it has been necessary to await the leisure of teachers of geology in various parts of the State, in order to secure particular specimens. No one who has not conducted similar work can appreciate the labor and pains involved in this undertaking. The value of the result will be understood by those who use it.

Some time since, the chairman of the museum committee requested the director of the museum to prepare a report on the road materials of New York. It seemed desirable to combine with this a report on the road building conditions of New York, and in gathering material for this purpose, the attempt was made to avoid the beaten track of similar publications and to procure new facts of importance rather than republish things already well known. Through the director's experience as an over-seer of highways in one of the districts of Albany county, it became possible for him to form a close acquaintance with local methods of road building and an accurate estimate of their value; so that a useful comparison could be made of the conditions existing in different parts of the state. An arrangement was made with the Massachusetts highway commission by which representative samples of materials used for road building in New York were tested in the laboratory of the commission at Cambridge. The results of this inquiry are completed and are in the printer's hands.[a]

[a] This report is published as Bulletin 17 of the New York state museum and is bound with the 50th report.

Together with the scientific and political study of this important question, the director has communicated with every proprietor of a stone quarry in New York state, in order to secure information concerning the local uses of stone in road building. The information thus obtained forms a directory to the road-metal quarries of New York and their distribution is illustrated by a map.

The director has been collecting from various sources photographs of important geologic formations in New York in order to make a representative series for the museum. These views will be further utilized in illustrating a *Guide to the study of the geologic collections of the New York state museum* in the preparation of which the director is at present engaged. In this connection a geologist has been in the field making photographs of localities along the lower Hudson river.

To further illustrate the "Guide" above mentioned and render clearly intelligible the physiography of the state, a relief map on the scale of twelve miles to one inch has been prepared and was exhibited at the University Convocation.

No accurate relief map of New York had been before undertaken, and the educational value of the one now completed can scarcely be over estimated. Copies in plaster can be purchased by educational institutions for $25, and, through the museum publications, photographic reproductions will be distributed gratis.

Two temporary field assistants Messrs T. G. White and D. H. Newland have made collections of rocks and minerals, respectively in the Mohawk valley and the highlands of the Hudson and Prof. C. H. Smyth jr of Hamilton college and Prof. R. S. Tarr of Cornell university are having collections made for our museum in the vicinity of their respective institutions.

In his administrative duties, apart from the daily routine work, the director has been occupied during the past two legislative seasons in the endeavor to secure a permanent increase of the museum appropriation. While the first season was full of promise it resulted only in a generous allowance in the supply bill which made it possible to carry the present salary list over another year. During the season just past renewed effort was crowned with success in so far as to increase the appropriation from $6720 to $10,000 with an additional allowance of $800 in the supply bill. This has been sufficient to pay the salaries.

This brief statement of the condition of the museum and its work, shows a status far more prosperous than was anticipated by the director when he was obliged to meet the difficult financial situation.

Owing to the great variety and amount of work necessary to keep the various collections in presentable appearance and to improve them, from time to time, by additions and rearrangements, and to the frequent interruptions of routine work, the assistant curator has been obliged to divide his attention among various subjects as circumstances required, rather than devote himself to any one line of work until its completion.

The greater part of the year has been occupied in developing the introductory geological collection, the New York state synoptical geological collection, in preparing a list of the more prominent natural history museums in the United States and Canada, with a brief outline of their respective collections; and in the identification of specimens (chiefly minerals) brought to the museum for determination.

During the autumn several weeks were occupied in the work of identifying and labeling a large collection of mineralogical and paleontological specimens that had been donated to the Cobleskill high school on condition that the specimens be properly identified and exhibited by the school. The collection was in very bad condition on its arrival at the museum, and the loss of time to the museum was so great that it does not seem advisable to accept another such task.

A catalogue has been prepared of all the ethnological and historical specimens in the museum, including the stored as well as the exhibited material. All catalogues of the exhibited collections and of the still greater amount of stored material, have been systematically arranged and a list of them prepared.

The collection of echinoderms has been rearranged and relabeled.

During the year many valuable additions to the collection of minerals have been made. A detailed list of these accessions will be found in the appendix to this report.

The cases are now so overcrowded that it is impossible to arrange the specimens so that all the labels can be read, and frequently a

new specimen can not be installed in its proper place without removing some other specimen. This process of weeding out the older material has reached its limit, and a further removal of specimens, as the collection increases, will weaken the exhibit. To obviate this difficulty and to make room for growth and for the introduction of labels dividing the mineral collection into the natural groups, (an addition which is urgently needed) a plan was prepared for a new arrangement of the table cases, by the use of which the space necessary for two new cases would be obtained. It has not, as yet, been possible to make this necessary change.

A little time has been spent on the new collection of birds nests mounted with the birds and their eggs, and several additions were made during the collecting season. A few additions have also been made to the collection of birds. A list of the accessions to both these collections will be found in the appendix to this report.

The space available for the exhibition of nests is already overcrowded and if the collection is enlarged the specimens of birds in another case must be unduly crowded.

The large relief map of the state, which was exhibited by the museum at the World's Columbian exposition, has been placed on exhibition in the museum. This map is 35′ 2¾″ long (east and west) and 26′ 2¾″ wide (north and south); the horizontal scale is one inch to the mile and the vertical scale is one inch to 500 feet. It lies on the main floor in the rear wing of the building, and is enclosed by a railing and a raised platform. The best view of the map is obtained from the first gallery above it.

Three smaller relief maps have been added during the year. They are, a map of the state on a horizontal scale of one inch to 12 miles and a vertical scale of one inch to 12,600′, a map of southern New England including Massachusetts, Connecticut and Rhode Island on a horizontal scale of one inch to 2 miles: and a map of New York city and vicinity on a horizontal scale of one inch to one mile and a vertical scale of 3 inches to one mile. They are mounted on easels in the same room with the large map.

The maps of southern New England and of New York city and vicinity were purchased from Mr Edwin E. Howell of Washington, D. C. They are based on the topographic survey of the federal government in cooperation with the states of Massachusetts, Con-

necticut, Rhode Island and New York and have a high educational value. The small map of New York state was modeled for the New York state museum by Mr Howell, from a topographic map compiled for the museum by Mr C. C. Vermeule of New York city. This small map is of great importance to teachers of geography in New York. It is sold by Mr Howell at $25 and a copy of it should be in every school in the state.

As before stated a systematic effort has been made during the year to obtain photographs of geologic subjects. This collection is designed to illustrate outcrops and exposures of the various geologic formations, geologic processes and phenomena, methods and appliances used in quarrying and mining, etc. Although considerable material has been collected, no exhibit has yet been prepared. This collection contains 324 views. A list of the views represented will be found in the appendix to this report.

An attempt has been made to compile a list of the geologic museums in the United States and Canada, with a brief note of what their respective collections contained and a circular letter was addressed to the various museums, universities, colleges and scientific societies. This was published in the 50th report of the museum. After going thus far it was deemed advisable to compile a more complete statement of the collections in all branches of natural history. Accordingly a circular letter stating the use to be made of the information, was again sent to the various museums, accompanied by a blank form for information under the following heads: 1. Name and address of museum, name and title of the officer in charge and a list of the museum staff. 2. Paleontological collections include: (names and size of various collections, type specimens, formations best represented, etc.) Estimated number of specimens. Specimens for exchange. 3. Mineralogical collection contains: (collections, localities and groups best represented, etc.) Estimated number of specimens. Specimens for exchange. 4. Collections in historic and economic geology and in lithology, illustrate what? Estimated number of specimens. Specimens for exchange. 5. Zoological collections include what? Estimated number of specimens. Specimens for exchange. 6. Botanical collections include what. Estimated number of specimens. Specimens for exchange. 7. Ethnologi-

cal or anthropological collections include what. Estimated number of specimens. Specimens for exchange. 8. Mention any important features of the museum not enumerated above.

In reply to about 227 blanks sent out, about 140 were returned with the desired information more or less completely stated.

Information concerning the institutions that have not replied will be obtained elsewhere, so far as possible. This compilation will soon be completed.

The introductory geologic collection has been practically completed, except for the prospective addition of better specimens and the filling of blank spaces, which will occur from time to time. This series of illustrations of geologic terms and definitions is limited only by the space and means available, so that it is completed only in the sense that these limits have been reached. The cases have been rendered more nearly dust proof by inserting strips of plush under the covers; and the exhibition labels have been added. Much progress has been made on the synoptical geological collection of New York state. Several special collections from various parts of the state have been made to add needed material. A list of these accessions will be found in the appendix to the report.

With the exception of the small maps of the state showing the outcrops of each group, and the filling of a few spaces here and there, this series is now completed up to the carboniferous system.

Taken in conjunction with the introductory collection, this series is already attracting favorable comment from visitors and from the local press, and will prove of still greater interest when an explanatory handbook can be published to accompany it.

Work on the economic collection has been confined almost entirely to the collecting of material.

A splendid series of 21 specimens of potassium salts, and products manufactured from them, from the famous Stassfurt mines in Germany was presented to the museum by the German Kali works, proprietors of the mines. A list of these specimens will be found in the appendix to this report.

Other additions to the economic collection include road-metal, abrasive material, and a collection illustrating the occurrence of the talc veins at Talcville and Fowler, in St Lawrence county. This

series was collected by Mr J. N. Nevius and included specimens of the country rocks, the foot and hanging walls of the mines and the various qualities of the talc from mines no. 3 and no. 5 of the International pulp co., at Talcville and the American talc co. at Fowler, together with the manufactured product, and a series of photographs showing a vein of talc, the process of mining and the topography of the region. A list of these specimens will be found in the appendix to this report.

The duplicate geological and mineralogical material stored in various parts of the building has been accumulating for years without any arrangement or system by which a particular specimen could be found when needed. A beginning has been made to arrange this material systematically and to catalogue the drawers and cases containing it. All the duplicates from the general mineral collection have been arranged and considerable progress has been made with the geological material.

During the year there has been a great increase in the number of persons using the museum as a bureau of information. Most of these have wanted minerals identified, many have wanted specimens assayed and others have asked for practical information concerning various economic minerals. With the exception of making assays, for which the museum is not equipped the museum has been able to give satisfaction to all applicants.

Between July 1 and September 30 there were upwards of 110 specimens received from all parts of the state to be tested for gold. This is an average of more than one a day, and as many as eight have been received in one day; and these for gold alone. That the equipment of the laboratory and the amount of time that the assistant curator can devote to this work are inadequate needs no demonstration.

During the month of September, weekly visits to the Hudson river were made by the assistant curator for the purpose of collecting Unionidae at the time reproduction was beginning. These collections will continue until the river is frozen, and the gills of the specimens containing eggs will be preserved, thus forming a series of specimens showing the development of the eggs into the embryonic young.

WYNKOOP HALLENBECK CRAWFORD CO., NEW YORK AND ALBANY.

The attendance of visitors at the museum for the year just past as shown by the following record was somewhat greater than that of the previous year.

Four scientific papers are published as appendices to this report.

A Report on the relations of the Ordovician and Eo-Silurian rocks in portions of Herkimer, Oneida and Lewis counties, by Theodore G. White, Columbia university.

B Some higher levels in the postglacial development of the Finger Lakes of New York State.

A thesis presented to the faculty of Cornell university for the degree of doctor of philosophy, by T. L. Watson.

C The talc industry of St Lawrence county, New York, by J. Nelson Nevius.

D The history of Cayuga lake valley, by J. Nelson Nevius.

Appendix B is published by request of Prof. R. S. Tarr of Cornell University, under whose supervision the work was done. The subject is of such general interest that it seemed well to print it for distribution to the people of New York state.

RECORD OF ATTENDANCE AT THE MUSEUM

From Oct. 1, 1896 to Sep. 30, 1897

Total attendance	53 366
Greatest monthly maximum, August	6 931
Greatest daily maximum, January 6	569

Respectfully submitted

FREDERICK J. H. MERRILL
Director

Additions to the geological collection

FROM OCTOBER 1, 1896 TO SEPTEMBER 30, 1897

Donations

The geological department of Columbia university presented to the museum, through Prof. J. F. Kemp, 1 large specimen of Limburgite, from the Thetford boulders, Thetford, Vt.

A collection of 82 small specimens of the rocks from the mining districts of Essex county, New York. The specimens are mostly Pre-cambrian crystalline rocks.

A few months later, Prof. J. F. Kemp presented to the museum a collection of 28 specimens of the rocks of Essex county, New York. These specimens are duplicates of some of the former collection, but are much finer specimens.

Through the courtesy of the state geologist, the museum received a specimen labeled: "Piece of wood believed to be of pre-glacial growth taken from a stratum of peat about 6 inches thick, underlying 8 feet of the boulder clay. Found in making excavations for the intake pipe for the Watertown city water works, near the settling basin, on the farm of Hubart Isham, October 1896. Presented by F. A. Hinds."

A collection of 21 bottles of the various potash salts from Stassfurt, Germany and the products manufactured from them, was presented to the museum by the German Kali Works of 93–99 Nassau street, New York. The series included the following material

Chlorkalium, (Potassium chloride manufactured from Sylvite)
Carnallit
  " with peat, pulverized
  " pulverized
Polyhalit
Kalidunger, (Potash fertilizer, manufactured)
Kohlensaures kali magnesia, (Potassium magnesium carbonate manufactured from Sylvinit)
Schoenit (Picromerite)
Kieserit (Kieserite)
Berg-kieserit (Carnallite of low grade)
Steinsalz (Halite Rock salt)
Steinsalz–jungeres (Halite from upper strata)
Hartsalz (Halite, Sylvite and Kieserite)
Sylvinit (" " Kainite)
Sylvinit (" " " pulverized)
Sylvin (Sylvite)
Kainit (Kainite)
  " (" pulverized)
  " (" with peat, pulverized)
Schwefelsaures kali (Potassium sulphate, manufactured)

Specimens of white quartz quarried at Billings, Dutchess county by the Bridgeport wood finishing co., of New Milford, Ct. The quartz is used for making wood filler.

2 specimens of Chlorite schist, from Harthau, Saxony.

From Mr J. L. Davison, Lockport, N. Y., a large cluster of iron stained quartz crystals, and two gypsum concretions from an excavation for the Erie canal at Lockport.

By purchase

From Oscar Rohn, Madison, Wis., a collection of 85 specimens of the various formations of the Archaean, Algonkian, and Cambrian systems, illustrating the geology of the Lake Superior region. Each specimen is from the typical exposure of the formation it represents, and its label bears a reference to the published description. A chip of similar rock from which microscope sections can be cut, accompanies each specimen.

Material collected for the museum

Prof. Ralph S. Tarr of Cornell university, had made a collection of 84 specimens of the rocks about Ithaca, N Y. They illustrate the variations in structure of the various beds of the Hamilton, Portage and to a less extent of the Chemung, Corniferous and Salina groups. It is a very complete collection of the rocks of that vicinity.

Prof. C. H. Smyth jr of Hamilton college, collected a series of 19 specimens illustrating the formations about Clinton, New York. They represent the formations from the Oneida Conglomerate to the Corniferous group.

Prof. I. P. Bishop of the State normal school at Buffalo, collected a series of 28 specimens chiefly from the Niagara gorge and the vicinity of Lockport, Niagara co.

The collection includes

1 specimen	Hamilton sandstone.
2 specimens	Stafford (Marcellus) limestone.
2 specimens	Onondaga limestone.
1 specimen	Corniferous "
5 specimens	Waterlime "
2 specimens	Salina shale.

6 specimens Niagara shale and limestone.

1 specimen Clinton limestone.

8 specimens Medina sandstone.

Mr D. H. Newland collected 142 specimens of the crystalline rocks of the region between Cold Spring, Putnam co., and Peekskill, Westchester co.

Material collected in St Lawrence county by J. N. Nevius

Potsdam sandstone

3 specimens from Merritt & Tappan's quarry, 4 miles south of Potsdam.

3 specimens from Clarkson quarry 3½ miles south of Potsdam.

5 specimens from Dodge farm, Macomb.

2 specimens from Popes mills.

Miscellaneous

2 specimens breccia from Lon Smith farm, North Gouverneur.

3 specimens soil from decomposition, Potsdam.

Crystalline rocks

2 specimens marble from Stevens quarry near Canton.

3 specimens marble from St Lawrence marble co. quarry Gouverneur.

1 specimen marble from Northern New York marble co. Gouverneur.

1 specimen marble from Empire marble co. quarry, Gouverneur.

2 specimens marble from the wall rock at a pyrite mine on Belmont farm, Little York, Fowler.

4 specimens containing pyrite, galenite and sphalerite from same mine.

2 specimens granite from near Macomb postoffice.

6 specimens granite from Dodge farm, Macomb.

2 specimens gneiss from Rossie.

4 specimens gneiss from Talcville.

Pulverized talc.

Samples of "Special asbestus pulp," "Super stock" and "Finished asbestus pulp," from the International pulp co. Gouverneur.

Samples of "No. 1, Buhr stock" and "Fine cylinder stock" from the United States talc co. Gouverneur.

A sample of "Cylinder stock" from the American talc co, Fowler.

A series of 36 specimens illustrating the country rock, the foot and hanging walls of the mines and the various qualities of the talc from mines nos. 3 and 5 of the International pulp co. at Talcville.

Also a number of miscellaneous specimens from the other mines, in the vicinity — particularly from the mines of the American talc co. at Little York, Fowler.

Road metal

3 specimens limestone from the Howe's Cave association, Howe's Cave, N. Y.

5 specimens granite from D. E. Donavan, Round Island, N. Y.

2 specimens trap from the Bouker contracting co. Guttenburg, N. J.

1 specimen sandstone from F. E. Conley, Higginsville, N. Y.

4 specimens trap from Foss & Conklin, Haverstraw, N. Y.

3 specimens sandstone from Chas. Whitmore, Lockport, N. Y.

4 specimens bluestone from Albert Shear & Co. Schenectady, N. Y.

1 specimen granite from John McGovern, Peekskill, N. Y.

2 specimens trap coll by H. Ries from top of Palisades.

3 specimens trap coll. by H. Ries from Bouker's quarry.

2 specimens trap coll. by H. Ries from Lane's quarry.

1 box assorted sand and gravel used in concrete making from N. W. Godfrey, East River storage yards, New York city.

Additions to the mineral collection

By donation

Received from M. B. Hirsch of Albany, an amber pipe stem made in Russia, the amber is from the coast of the Baltic Sea.

By exchange

From Mr H. S. Peck of Menands, N. Y., 1 specimen of Colemanite, crystallized, from San Bernardino co. Cal.

From Otto F. Pfordte, Rutherford, N. J.

1 specimen Placer Gold, from Sandia City, Sandia, Peru.

1 specimen Placer Gold, from Sandia, Peru.

1 specimen gold, with calcite, bornite and hematite, interior of Cerro de Pasco, Peru.

1 specimen silver, from Batopilillos, Chihuahua, Mexico.

1 specimen Scheelite from Mina Vanguardia, Casapalca, Peru.

1 specimen Brucite var. Nemalite from Hoboken, N. J.

1 specimen Mercury from New Almaden, Cal.

1 specimen Realgar from Mina Cuarenta, Casapalca, Peru.

1 specimen Nickelite, from Richelsdorf, Hessen, Germany.

1 specimen Edenite from Edenville, Orange co., N. Y.

1 specimen Ehritite from Schneeberg, Saxony.

1 specimen Galenobismutite from Falun, Sweden.

1 specimen Silver Ore from Casapalca, Peru.

1 specimen Linarite from Mina Vanguardia, Casapalca, Peru.

By purchase

1 specimen Sphalerite from Joplin, Missouri.

3 specimens Calcite from Joplin, Missouri.

2 specimens Flint from Dover, England.

By collection

ST LAWRENCE COUNTY BY J. N. NEVIUS

Many specimens fibrous talc, from the mines at Talcville.

1 specimen tremolite, near Gouverneur.

3 specimens Pyrite Galenite and Sphalerite, Edwards.

8 specimens Graphite near Rossie.

4 specimens Graphite from North Gouverneur.

3 specimens Fluorite from Macomb.

2 specimens Williamsite from Talcville.

7 specimens Hexagonite from Talcville.

SOUTH WALLINGFORD, VERMONT, BY J. N. NEVIUS.

A quantity of pure white kaolin (see E. & M. Journal, Aug. 14, 1897) and several specimens of limonite and of manganese ores.

Additions to the zoological collection

BIRDS NESTS AND EGGS COLLECTED BY J. N. NEVIUS

NAME	SCIENTIFIC NAME	DESCRIPTION	LOCALITY
Yellow-breasted Chat	Icteria virens, L	nest and 3 eggs	Bethlehem, Albany co.
American robin	Merula migratoria, L	3 eggs	Bethlehem, Albany co.
American robin	Merula migratoria, L	nest and 4 eggs	Bethlehem, Albany co.
Chestnut-sided warbler	Dendroica pennsylvanica, L	nest and 4 eggs	near Sand Lake, Rens. co.
Orchard oriole	Icterus spurius, L	incomplete nest	Bethlehem, Albany co.
Catbird	Galeoscoptes carolinensis, L	3 eggs	Bethlehem, Albany co.
Eave swallow	Petrochelidon lunifrons, Say	nest and 3 eggs	Braisie's Corners, St Lawrence co.

BIRDS COLLECTED BY J. N. NEVIUS

NAME	SCIENTIFIC NAME	SEX	LOCALITY
*Yellow-breasted Chat	Icteria virens, L	♂ + ♀	Bethlehem, Albany co.
Chestnut-sided warbler	Dendroica pennsylvanica, L	♂	Bethlehem, Albany co.
Black-poll warbler	Dendroica striata, Forst	♂	Bethlehem, Albany co.
Baltimore oriole	Icterus galbula, L	♂	Bethlehem, Albany co.
Yellow-bellied flycatcher	Empidonax, flaviventris, Baird	♂	Bethlehem, Albany co.
Red tailed hawk	Buteo lorealis Gmel	♀ immature	Albany co.

*Both birds were collected with the above mentioned nest.

Mammals

BY PURCHASE

From Joseph Lehner, 1 Canada porcupine, ♂, Erethizon dorsatus, L. Shot at McKownsville, Albany co. N. Y., July, 1897.

BY DONATION

From Prof. Chas. H. Peck, 1 red bat, Atalapha noveboracensis, Erxl. Menands, Albany co., N. Y.

BY PURCHASE

Plaster models of fishes, batrachians and reptiles made by Ward's natural science establishment.

Yellow perch, Perca flavescens, Mitch.

Small mouthed black bass, Micropterus dolomieu, Lac.

Northern rattlesnake, Crotalus durissus, L.

Coach whipsnake, Bascanium flagelliforme Catesby.

Bull Frog, Rana catesbiana, Shaw.

Invertebrates

1 specimen of coral from Hayti, unidentified, presented by George E. Mitchell, Brooklyn, N. Y.

APPENDIX A

REPORT ON THE RELATIONS OF THE ORDOVICIAN AND EO-SILURIAN ROCKS IN PORTIONS OF HERKIMER, ONEIDA AND LEWIS COUNTIES

By Theodore G. White

COLUMBIA UNIVERSITY

CONTENTS

INTRODUCTION

The notes and collections which are the basis of this report were made in the course of field work during the month of July 1897. The field work was undertaken for the purpose of locating, if possible, a complete section of the upper Ordovician rocks from the Birdseye or Black river limestone at least to the top of the Utica or Hudson river shales, within the area of the Trenton Falls paleontological province, from which a collection of rock specimens and fossils might be made for the New York state museum. As the writer has previously pointed out (White '96 & '96a) the type section of the Trenton formation at Trenton Falls, Oneida co., N. Y., from which the formation was originally described (Conrad '37, Vanuxem '42) is not a complete section. The lowest layers seen there, are at an unknown distance above the top of the Black river zones and the section terminates in gray crystalline layers which Darton ('93, p. 618–620) considers to represent the top of the Trenton, although at Amsterdam, where the crystalline layers are lacking, he says (l. c. p. 620) the thin bedded shaly limestones grade into the overlying Utica shales. Along Lake Champlain, which may be considered a border of the Trenton Falls province, it is possible to construct a continuous section from the Calciferous, well up into the Utica. But although the paleozoic seas were doubtless continuous around the Adirondack island, the local environment and conditions of deposition varied considerably, so that intermediate stages of faunal development occurring on one side of the Adirondacks are lacking on the other, and local oscillations of the Ordovician land-surface have produced different sequences in the more or less impure limestone strata.

Gradual thickening of the Ordovician sediments[a] is, moreover, shown toward the western part of the state, so that a broader faunal range is likely to be found there. Correlation with the Trenton limestone has been attempted all over the country and this has led to much confusion of terms because, although many species have been described from various positions in the New York Trenton, no systematic study of the sequence of strata and their contained faunas within the paleozoic province of Trenton Falls has yet been published which embraces all the zones originally deposited in the region. Stratigraphic work of this sort has already been done in several other groups of the Ordovician, notably for the type section of the Chazy formation and the area in its vicinity. (Brainerd and Seely '88, '91, & '96). It has also been done for the Quebec group (Logan '63 p. 227), and for those portions of the Cambrian which

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[a] The rate of this thickening is shown in the following table by the correlation of sections at the places mentioned, or in their immediate region ; the localities being in an approximate line, over 175 miles long, extending from west to east across the central part of the state.

LOCALITIES	Rochester[1].)		Chittenango[2].)		Utica[3].)		Amsterdam[4].)
DISTANCES		<90 miles>		<32 miles>		<55 miles>	
Clinton	80 ft.		323 ft.		226 ft.+		
Medina	1075 "		520 "				
Oswego–Oneida	83 "		107 "		16 ft.+		
Utica-Lorraine	598 "		873 "		800([5]) ft.		("at top.")
Birdseye-Trenton	954 "		637 " +		350 ft.+		37 ft.
Calciferous	137 "		329 "		? .. ("180 ft gap")		("at base.")

1) Fairchild '91 p. 184. 2) Prosser '93 p. 108. 3) Walcott '88 pp. 211–212; Prosser '93 p. 100; and the present paper, p. r44. 4) Darton '93 p. 620. 5) Thickness 600 feet acc. Walcott '83 p. 1, and 710 feet according to the same author '90 p. 347. 6) Thickness 456 feet acc. Prosser & Cumings '98 p. 634.

The following is a summary of statements by Hall ('74)

	160 miles west of Schoharie in line from Seneca or Ontario to Oswego co.	60 miles west of Schoharie. (Meridian of Utica.)	Schoharie valley. (Meridian of Amsterdam.)
ORISKANY SANDSTONE		Present	Present.
LOWER HELDERBERG.	Represented by a few feet of compact, grayish-blue limestone.	Not distinctly developed. Indistinguishable. Present	Upper Pentamerus limestone. Shaly limestone. Lower Pentamerus limestone. Tentaculite limestone.
WATER LIME FORMATION		Present	Present.
ONONDAGA SALT GROUP (with gypsum beds 1000'.)		Present (Red and gray marls.)	Absent.
NIAGARA GROUP. (=Coralline sl..)		Present	Present.
CLINTON GROUP		Green shales and sandstone with calcareous bands, containing interstratified beds of red hematite.	Green shale with iron pyrite.
MEDINA SANDSTONE		Present	Absent.
HUDSON RIVER GROUP		Present	Present.

derive their names from localities in this country, namely the Georgian (Walcott '91 p. 278–279) and the Etcheminian and St John group (Matthew '92 and '95).

The desired section for description, embracing all the zones developed in the Trenton Falls province was not found in the few weeks spent in the field last summer. The writer is convinced however that it will be found by further search.

The present paper however adds several details on the border of the areas occupied by the formations, as depicted on the state economic and geologic map (Merrill '95) and the preliminary geological map (Hall '94) and shows that the border of the crystalline rock extends further west than is indicated on either of them.

The area covered this year is in the vicinity of Frankfort Hill, Herkimer county, and from Rathbone, near Newport, to Lyon Falls, Lewis county, in detailed field work, and thence on to Carthage in hasty inspection. This may be defined as a portion of the West Canada creek and Black river valley.

The formations enumerated are from the crystallines through most of the Clinton stage as there developed.[a]

CRYSTALLINE ROCKS

The crystalline rocks are similar in character to those of the eastern side of the Archaean Adirondack island. Along all the tributaries of West Canada creek Archaean appears in isolated outcrops, at some distance up-stream from the nearest paleozoic outcrop, which is last met with at Hinckley. From Hinckley the southern tributary (Black creek) meanders through black silt and sand until Mount creek is passed (Locality 134). The rock here

[a] The system employed in recording field notes was that developed by Prof. Henry S. Williams, during his study of the Devonian formations of central New York. The town which is the temporary headquarters for field work of the vicinity is assigned a definite number as 130=Trenton Falls. During the progress of the work in that vicinity every exposure or continuous section is assigned a letter of the alphabet, whether the section be along a shore, in the bed of a stream, a railroad cutting or a quarry. In the case of sedimentary rocks, the geologically lowest layer in that section is sought and numbered 1; each superjacent distinct layer being numbered in series, and measured, and a quantity of representative material collected from each, as described in the case of similar work by the writer (White '96).

The field numbers have been retained in the left-hand margin of the sections described in the present paper, although in some cases several layers distinguished in the field have been combined, as will be seen, where subsequent laboratory study failed to detect sufficient distinction between them to warrant their separation.

is gneissoid, containing much biotite, garnets and often, crushed feldspars. The foliation banding of the ledges bears N 65° E. Outcrops of the same character are seen from this point northward along Mount creek (loc. 135). The other streams in the town of Ohio, Herkimer co., are in a sand plain and show no outcrops in their channels.

The north or main tributary of West Canada creek has no outcrop exposed in its valley until Northwood is reached; and flows for four miles between sandy banks of drift, often with high terraces. There is an outcrop of crystalline rock beneath the saw-mill at Northwood and on the neighboring hillsides (136). It is less gneissic and more feldspathic than that on Mount creek. The country rock between Hinckley and Forestport is deeply buried beneath sand hills and plateaus. At Forestport extensive outcrops of coarse hornblendic red granite occur along Big Woodhull creek, Alder creek and the "feeder" of the Black river canal (138). The stone is almost identical with the red granites of Maine and eastern Massachusetts. From Forestport to Hawkinsville the "feeder" has been excavated chiefly in loose material. Extensive outcrops of a handsome fine-grained light-gray gabbro (139 B) occur on Crystal creek in the center of the town of Hawkinsville and within quarter of a mile of ledges of Trenton limestone (139 A). No crystallines are seen in Boonville nor Leyden. Above the bridge at Port Leyden, Black river flows through a rather narrow alluvial plain without outcrops. At and below the bridge, (loc. 142 C) are large gabbro bosses similar to those at Hawkinsville but reddish in color. The masses of rock are very strongly banded in a vertical direction, with black streaks rich in biotite and somewhat gneissic. There are, also, numerous narrow quartz veins. From Port Leyden to Lyon falls the channel of Black river is entirely in the gabbro (143 D). The latter is strongly banded at Lyon falls, specially near the pulp mill, (143 A) (Fig. 1.) where the flowage lines have a direction of N 60° E. Where unaltered it is a dark colored rock, chiefly labradorite, with considerable pyrite and occasionally grains of quartz. The labradorite of the rock along Moose creek has weathered to a brilliant brick red (143 B & C).

FIG. 1.

To face p. 26.

T. G. White, photo.

LYON FALLS, N. Y.

BIRDSEYE FORMATION

The only locality of the Birdseye observed was at Rathbone brook. It is shown along West Canada creek at the mouth of the brook and in a railroad cut a short distance north. It is about 14 feet thick, coarse and yellowish in the lower layers, fine and dove-gray above with no fossils except calcite "nests" which may be replacements of *Scolithus* tubes.

BLACK RIVER FORMATION

Rathbone (near **Newport**) (130 B). The lower beds of the section are not well exposed on Rathbone brook itself and the Black river formation is not seen in contact with the lower Trenton in the immediate vicinity. In the railroad cut, a short distance north, already referred to, 6 feet, 9 inches of the Black river limestone is exposed which yielded the following species:

Illaenus americanus Billings	*Stictopora* sp.
Leperditia fabulites (Conrad)	*Rafinesquina alternata* (Emmons)
Avicula trentonensis Conrad	*Strophomena incurvata* (Shepard)
Cypricardites ventricosus (Hall)	*Ctenodonta levata* (Hall)
Raphistoma americana Billings	*Tellinomya nasuta* Hall
Zygospira recurvirostra Hall	*Isotelus gigas* DeKay
Cyrtoceras tenuistriatus Hall	*Protarea vetusta* (Hall)
Rhynchotrema inaequivalvis (Castlenau)	*Holopea* sp.
	Murchisonia sp.
Bathyurus extans (Hall)	*Modiolopsis* sp.
Dalmanella subaequata (Conrad)	*Bellerophon* sp.
Dinorthis cf. *pectinella* (Emmons)	*Conularia* sp.
Orthoceras sp.	*Isochilina* sp.

The rock is barren in some portions, crystalline and highly fossiliferous in others, especially toward the top; the fossils being brought out by weathering. Chert nodules occur in the rock. It is a nearly black, compact limestone, having a conchoidal fracture and weathering gray or yellowish.

Boonville. The Black river limestone is well exposed in the bed of Dry Sugar creek near Boonville quarries (140A). The beds dip 4° S 10° E, and are deeply seamed in all directions, so that the creek, although of considerable size, becomes a "lost" river in the crevasses just below the quarries and so remains nearly to its

juncture with Black creek. In the not very remote past the volume of this stream must have been great, for the extremely level floor of its bed is worn into innumerable pot-holes, three inches to six feet in diameter and still retaining the rounded boulders of granite, gabbro, and other hard rocks which formed them. (Fig. 2) Beneath the bridge, below the quarries, the ledges cease and the remainder of the channel of Sugar river as well as of Black river, into which it flows, is carved through boulder drift until the gabbro at Hawkinsville is reached, so that the contact with the Calciferous limestone is not seen. The section (140A) presented is as follows:

140A1;—Rather impure, tough, black limestone, 12 feet

Columnaria alveolata Goldfuss
Stromatocerium rugosum Hall
Zaphrentis canadensis Billings
Isotelus gigas DeKay
Euomphalus sp.
and large *Orthocerata*

140A2;—Zone of *Parastrophia hemiplicata* This appears to be a well marked zone of the upper Black river of New York, and is found in similar relations in the Lake Champlain valley. The *Triplesia* zone, that follows it here, has not yet been found in eastern New York, and the fact that large and smooth adult specimens of *P. hemiplicata* often so nearly resemble *T. extans* may indicate that the latter is a subsequent development from the former in central New York. The *Parastrophia* beds are shaly, with compact, dark gray seams. 1 to 4 inches thick, which are very fossiliferous. 5 feet

Parastrophia hemiplicata Hall
Plectambonites sericeus (Sowerby) (a large form resembling *P. saxea* Sardeson).
Dalmanella testudinaria (Dalman)
Isotelus gigas DeKay
Rafinesquina alternata (Emmons)
Ostracods
Lamellibranchs, too imperfect for identification.

140 A 3;—Zone of *Triplesia extans.* 3 feet

Plectambonites sericeus (Sowerby), very abundant.
Rafinesquina alternata (Emmons)

140 A 4;—Trenton. Thin layers of black, hard, almost flinty, barren limestone, with shaly alternatious and thin zones with

FIG. 2.

To face p. 28.

T. G. White, photo.

POT HOLES, DRY SUGAR CREEK, BOONVILLE, N. Y.

FIG. 3.

T. G. White, photo.

CLINTON. SWIFT CREEK SECTION, FRANKFORT, N. Y.

FIG. 4.

T. G. White, photo.

RIPPLE MARKS ON STRATA NEAR CHADWICK, N. Y.

well preserved fossils. These evidently represent the base of the Trenton. 12 feet

Rafinesquina alternata (Emmons)
Dalmanella testudinaria (Dalman)
Crinoidal columns
Zygospira exigua (Hall)
Orthoceras sp.

The Boonville section is not continuous above this, but exposures occur at intervals along the canal, Sugar river, and its tributaries, as far as the road between Boonville and Leyden, while far beyond this is a single outcrop of Utica slate, (141 A) further east than is indicated on Prof. Hall's map.

Lyon Falls. From Leyden to Port Leyden and thence nearly to the point where the Black river canal leaves the river, no sedimentary outcrops are seen, the surface being buried in sand hills. At the locality mentioned, an escarpment of Black river limestone appears (142A 1–2), forming, as it were, at a height of at least 150 feet above the river, a retaining wall for the level country extending westward at that higher altitude. The strata exposed in the escarpment at the top of the slope are about 20 feet thick. The lower portion (142 A 1) is a rather compact, dark gray limestone (142 A 2) with numerous calcite veinings, containing *Leperditia fabulites* and *Isotelus gigas*. The upper portion is more impure.

A continuation of the same escarpment of about the same thickness is seen west of the railroad station at Lyon Falls (143 E 1–2). The lower portion is a bed of *Leperditia fabulites* (Conrad) with *Isotelus gigas* De Kay, as in the (142 A) locality. The upper is a dove colored limestone with pyrite. In neither locality are the adjacent formations seen.

TRENTON FORMATION

Rathbone brook. As above mentioned (p. r27) the sequence of the beds from Black river to Trenton is not shown in the Rathbone brook section. The following zones may be established by correlation of the details in the writer's previous paper (White '96, p. 84–87), those at the base of the brook section being compared with those on the neighboring hillside.

130 B1–2 & A 9–10) Zone of *Monticuliporidae.*

Dalmanella testudinaria (Dalman)
Plectambonites sericeus (Sowerby)
Isotelus gigas De Kay
Protowarthia cancellata (Hall)
Platystrophia biforata (Schlotheim)
Murchisonia milleri Hall
Calymene senaria Conrad
Strophomena rugosa Blainville
Trinucleus concentricus (Eaton)
Ceraurus pleurexanthemus Green
Rafinesquina alternata (Emmons)

Approx. 35 feet

130 B 3–6;—Sub-zone of *Holopea symmetrica* Hall, in which all the above, except *Protowarthia cancellata*, were found, and in addition the following:

Trematis terminalis Emmons
Lingula riciniformis Hall
Lingula aequalis Hall
Eccyliomphalus trentonensis (Con.)
Conularia trentonensis Hall

20 feet

130 B 7;—Sub-zone of *Trinucleus concentricus* (Eaton). Contains nothing else. 7 feet

130 B 8–13;—Remainder of *Monticuliporid* zone, containing only, in addition to the corals,

Rafinesquina alternata
Calymene senaria
Plectorthis aequivalvis
Dalmanella testudinaria
Dalmanella subaequata
Modiolopsis sp.

12.5 feet

130 B 14;—Zone of *Parastrophia hemiplicata* and *Orthoceras.* It has included nodules. Also

Calymene senaria
Dalmanella testudinaria
Monticuliporid corals
Platystrophia biforata
Ctenodonta levata
Lingula riciniformis
Rafinesquina alternata

9 inches

130 B 15–19;—Zone containing *Plectambonites sericeus* exclusively. 9 feet

130 B 20–23;—Zone of agglomerated *Dalmanella testudinaria* with occasionally

Calymene senaria
Rafinesquina alternata
Rafinesquina deltoidea
Plectambonites sericeus
Monticuliporid corals

5 feet

130 B 24–31;—Zone of *Isotelus gigas* and *Lingula curta*

Monticuliporidae	*Strophomena incurvata*
Calymene senaria	*Ctenodonta dubia*
Dalmanella testudinaria	*Ctenodonta levata*
Dalmanella subaequata	*Rafinesquina alternata*
Orthoceras vertebrale	*Rafinesquina deltoidea*
Protowarthia cancellata	*Diplograptus amplexicaulis*

46 feet

The section thus far is continuous. Above this, beds, presumably of about three feet in thickness, are invisible. Following this, appears

130 B 32;—Hard black, impure limestone in thin layers, often encrinal. This forms the fall near the stone bridge and the bed of the brook above it to the branch. *Strophomena incurvata* occurs in the lower part. Abundant large *Isotelus gigas* throughout, also *Orthoceras proteiforme*, the latter very abundant in the upper part. 40 feet

130 B 33; — The succeeding layers are again covered for some distance. On the north branch then appears 9 feet of sandy, thin-bedded, gray, finely crystalline limestone, containing no fossils except comminuted crinoids and trilobites. An outcrop of the same rock, 11 feet thick, occurs on the south branch. Both branches rise in swamps without further outcrops.

West Canada creek section—Prospect. At the suggestion of Prof. C. S. Prosser, the writer remeasured the Trenton Falls section (described on p. 76–80 White '96) and discovered an error of 33 feet in beds 12–13, caused in transcribing partially obliterated figures in the note book of the previous visit.

Beds 130 D 1–4 are repeated in D 5–7 so that the total thickness of the Trenton Falls section is 268 instead of 325 feet.[a]

The dip of the strata changes quite abruptly at Prospect: the upper end of the gorge section. Below the quarries, as seen from the bridge, it is 20° N. Beneath the bridge it is 10° S, around the

a Since the above was written, Prof. Prosser's paper has appeared, in which my corrected figures are given (Prosser 98, p. 626) together with his own calculations of the Trenton Falls section, which differ by only two feet. In neither of the sections described by Prosser and Cumings was a complete series of the entire Trenton group secured.

first bend it is 9° S 30° E, but above the bridge all the beds are considerably folded and are also a repetition of the beds seen in the gorge, in decreasing order as one proceeds up stream.

Hinckley. An isolated outcrop of 15 feet of light gray, rather coarsely crystalline limestone, alternating with encrinal shaly limestone, apparently rather high Trenton, occurs beneath the bridge at Hinckley, (133 A). The limestone is quite soft, with numerous more or less comminuted fossil remains.

Ceraurus pleurexanthemus	*Platystrophia biforata*
Isotelus gigas	*Dalmanella testudinaria*, abundant.
Crinoidal columns, abundant.	*Bryozoa*

Above this the river flows deep and sluggish between banks of black mud and sand.[a]

Grant. Opposite the saw-mill on Black creek in the town of Grant, about ten feet of rather low Trenton is seen (133 B). It is impure and nodular with crinoids and monticuliporids. Black creek above this, as far as the town of Gray, shows only stratified dark gray clay.

Hawkinsville. From Hinckley to Forestport and thence to Hawkinsville, the crystalline-sedimentary contact can not be traced on account of the deep sand deposits. An extensive peneplane at an elevation of 1200 feet, surrounds Forestport and extends for miles. It is entirely of sand and largely barren of vegetation (Brigham '88 p. 114). This plateau falls off abruptly on the west, in a line which the canal approximately parallels although at some distance from it; the escarpment of its edge being bare and sharply defined in the distance. None of the streams have cut to the base of this sand plain.

On a small stream near the tow-path bridge just south of Hawkinsville, three feet of horizontal layers of Trenton are exposed (139A). These contain

Dalmanella testudinaria	*Isotelus gigas*
Plectambonites sericeus	*Ceraurus pleurexanthemus*
Rafinesquina deltoidea	

[a] On the occurrence of diatomaceous earths among the glacial deposits at Hinckley, see Cox, C. F. Trans. N. Y. acad. sci. 12; 219-220 and 13; 101.

FIG. 5.

To face p. 33.

T. G. White, photo.

FALLS OF THE SUGAR RIVER AT LEYDEN (TALCOTTVILLE), N. Y.

As before mentioned (p. r26) this outcrop is within a quarter of a mile of the outcrop of crystalline rock.

One mile west of Hawkinsville, in a field west of the turnpike, a ledge was found (139C) three feet thick, gray, very crystalline and abounding in *Dalmanella testudinaria*, gastropods and bryozoa.

Protowarthia cancellata *Isotelus gigas*

Boonville and Leyden. As before stated a non-continuous section is cut by Sugar river from Boonville to Leyden. The highest beds of this section are seen at the Talcottville quarries (141C), where 62 feet of encrinal Trenton layers occur, dipping 3°S 20° W. (Fig. 5) The layers are 6–15 inches thick, with thin, shaly partings, the latter very fossiliferous. Orthids occur in great abundance, one layer 8 to 10 feet below the top of the mass being filled with a large form of *Dalmanella subaequata*.

UTICA-HUDSON (FRANKFORT SLATE)

On a branch of Sugar river just east of the road from Talcottville to Constableville the Utica boundary was established. The river between, follows an older river bottom without outcrop. At the place referred to, the edge of a shaly ledge about 2½ feet thick appears (141A) which, except for the extent which it covers might be considered a large boulder. For the most part it is brown and decomposed, but fresher fragments contain *Triarthrus becki*, *Orthis* and a small *Orthoceras*, which also occurs in the shales at Frankfort.

The Black river formation escarpment begins a few hundred yards east of the gabbro, but with no observed contact, and in general, for some miles parallels the railroad and canal. The gabbro appears west of the railroad at intervals, all the way from Lyon Falls to Glendale, and in more scattered outcrops over half way between Martinsburg station and Lowville. The first Trenton outcrop on the railroad is in a culvert one mile north of Lowville. Beyond this the railroad follows a sand-plain until Carthage is reached. The Trenton strip is therefore narrower than has been supposed, and the white area east of Lowville on Prof. Hall's map ('94) should be colored as Precambrian. It appears that the contact between the crystallines and the sedimentaries is in general a little west of the railroad, and from the abrupt

nature of the Black river limestone escarpment. that it is probably a fault contact. The streams cut the crystallines, or ancient valleys eroded in them, that have been deeply filled with sand. The continuous section which is desired should be sought on tributaries entering Black river from the west. As so far observed the Boonville section is the nearest approach to such an ideal section, but that is far from satisfactory.

In addition to the work above described, the director of the state museum desired the writer to make, if possible, a section in the vicinity of Frankfort Hill, Herkimer county from the Ordovician through the Lower Helderberg, and to collect rocks and fossils.

The area covered to secure the following results embraces the towns of Frankfort, Center, Frankfort Hill, Chadwick and Sauquoit.

Type section

137 A ;—The type section of the Frankfort slates (Vanuxem '40, p. 372) is on Moyer creek, Frankfort. The creek is called "Frankfort creek" in the report cited, and is misspelled "Myers creek" in Vanuxem's report ('42, p. 63, etc.) The strata beneath the slates are not shown.

The section is as follows:

137 A 1;—First exposure at the bridge on the farm road which leaves the road from Frankfort to Sauquoit, $1\frac{1}{4}$ miles west of Frankfort. (Fig. 6) (No outcrops occur between this point and the Mohawk.) Black thin-bedded shales with conchoidal fracture as if under stress. Dip 3° to 4°, S 60° W. Fault planes N 40° W and N 25° E. At 17 feet above the base a thin layer contains Graptolites and a small species of Orthoceras. Total thickness of the exposure, 20 feet

A 2;—Gray sandstone, weathering red, overlying A 1 in the small brook which enters the creek near the bridge above mentioned 6 feet

Along Moyer creek gorge for nearly three miles the same alternating series of shales and thin bedded sandstones is shown in cliffs at least 90 feet in height; so that the total thickness of the Frank-

FIG. 6.

To face p. 34.

T. G. White, photo.

FRANKFORT SLATES ON MOYER CREEK, FRANKFORT, N. Y

fort shales must be over 100 feet.[a] No fossils were found above the zone referred to. Rounded concretions frequently occur in the slate. The thickest sandstone layers, ("rubblestone" of Eaton) are two feet thick. These sandy layers increase in abundance toward the upper portion of the mass, and may indicate passage beds to the Medina. The latter formation was nowhere found.

The gorge of Moyer creek, known as "the gulf," was followed to its termination above Gulph in search of the beds of the Oneida conglomerate and the red shales at the base of the Salina stated by Vanuxem ('42 p. 76 and 96) to occur there. Many boulders of both, some of them of large size, occur along the gorge, but no ledge could be found anywhere in the vicinity. The evidence afforded by boulders in this region is wholly untrustworthy, since the drift deposition is enormous, as notably illustrated about Forestport. (See Brigham '89 p. 113–114 and '95, also Chamberlain '83.)

Ferguson creek section ;—137 H ;—West branch of Ferguson creek, on the north side of Frankfort Hill.

H 1–2–3;—FRANKFORT SLATES in the bed of the western branch of the creek beginning near its union with the creek. In appearance exactly the same as the Moyer creek exposures. Dip 5° S 50° E. Directions of faultings, N 70° W and N 35° E, very pronounced. Lower portion entirely shaly, black, showing conchoidal "pressure fracture." Upper portion with intercalated, grayish, sandstone layers. Fossils occur only in one thin seam near the base. These are

Triarthrus becki *Orthis* (small species.)
Orthoceras (small species, same as in 137A1 and 141 A. common.)

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a Vanuxem ('42 p. 372) says "The upper part of the Frankfort slate in many places alternates with thin layers of fine grained sandstone, more or less intermixed with the matter of the slate; both by long exposure to the air assume a dark green or olive colour, by which they are readily distinguished from the black (=Utica) slate, which changes to a brown. Fossils are rare in the lower part of the Frankfort slate but are numerous in the upper part where it adjoins the next series, the Pulaski shales . . . To which of these two masses they belong has not been determined."

Vanuxem's classification ('42 p. 60–61) is

Hudson river group { Upper division = Pulaski.
Lower division = Frankfort shale and rubblestone.

Utica group, thickness 200 feet.

A long series of water falls, two of which are shown in the photographs (Fig. 7 and 8), occurs on the stream, all of which are over cliffs worn in the gorge of this shale which evidently forms the greater part of the hill on that side. The thickness of the shales therefore, according to the contours indicated on the map, must be fully 160 feet. Occasional drift covered patches render close measurement impossible. Strata equivalent to at least 30 feet in thickness are covered by drift at the top of the shales. Following the shales at the upper water fall is

H 4;—ONEIDA (?) CONGLOMERATE. Rather fine grained. One lenticle contains fragments of *Lingula*. 7 feet

These conglomerates are much contorted in the lower layers, while the other layers are not, and the shales above and below them are not. They are possibly of Oneida age. The disturbance appears to have been at the time of their deposition. Again, above this, drift obscures a considerable thickness.

H 5; — CLINTON. Green shales near the source of the stream barren of fossils, alternating with green sandstone and fine conglomerate. No continuous section of the beds.

ONEIDA CONGLOMERATE STAGE [a]

137 G 1-4; — Quarry on the road from Center to Utica,[b] near section H. (The altitude would indicate that this nearly corresponds to H 4.) Dip 5° S 55° W.

Alternating layers of coarse sandstone, quartzite and conglomerate, in beds ½ to 2 feet thick. Total 15 feet

137 K;—Quarry one mile east of Washington Mills. Dip 6° W. Probably equivalent to G 1-4.

K 1 Pyritiferous conglomerate, 2 feet+
2 Heavy sandstone, 6 feet.
3 Fine gray sandstone
4 Coarse conglomerate } 8 feet
5 Fine white sandstone

The red color of the soil above K5 indicates that the Clinton beds follow soon after.

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a Jewett ('64) states that the Oneida is the northern extension of the Medina, from the fact of finding *Arthrophycus harlani* in the Oneida at Utica.

b Presumably this is Johnson's quarry referred to by Brigham ('89 p. 105.) which he says occasionally shows layers of soft, dark shale, between the conglomerate beds.

FIG. 7.

To face p. 36.

T. G. White, photo.

FRANKFORT SLATES AT FALLS OF WEST BRANCH OF FERGUSON CREEK.

FIG. 8.

To face p. 36.

T. G. White, photo.

FRANKFORT SLATES AT FALLS OF WEST BRANCH OF FERGUSON CREEK.

CLINTON STAGE

137 L; — Abandoned iron quarry (Jones quarry.) at top of the hill above K, near the cemetery and a short distance west of Graffenberg brook. (137 C.)

L1; — Clinton ore bed; chiefly covered by debris.

2; — Green shales, dip nearly horizontal. Fossils in one thin layer. 12 feet

Anoplotheca plicatula (Hall)
Anoplotheca hemispherica (Sowerby)
Atrypa (?) *gibbosa* Hall
Avicula emacerata Conrad?
Beyrichia sp.
Calymene clintoni Vanuxem
Camarotoechia (?) *neglecta* Hall
Crinoidal columns
[a] *Cyclonema cancellatum* Hall
Dictyonema sp.
Fenestella sp.
Lamellibranch sp.
Lingula sp.
Monograptus clintonensis Hall
Orthoceras
Orthis sp.
Stitcopora sp.
Stropheodonta corrugata (Con.)

137 C; — Graffenberg brook (feeder to Savage reservoir) near where it crosses the road from Frankfort Hill to Washington Mills.

Green shale, apparently the same as 137 H5, but much sheared. 5 feet

In the upper part it contains

Camarotoechia (?) *neglecta* Hall
Atrypa (?) *gibbosa* Hall (abundant)
Plectambonites transversalis (Wahl.)

It occurs in thin seams, interstratified with green sandstone, which weathers yellow.

137 E; — Rogers' or Robinson's glen, Chadwick mills. (="Swift creek" of Vanuxem '42 p. 84, etc.) along the stream flowing into Sauquoit creek opposite what is now Willowvale bleachery: formerly Rogers' machine shop. Lower beds covered by masonry.

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a On the distribution of this and other Clinton species see papers by Foerste, also Claypole '89.

E 1 137;—First beds observable in the stream. Green shales with occasional quartz pebbles and interbedded thin sandstone layers. In portions the rock resembles a green schist. The upper portion of the shales is barren and talcose. The surfaces appear slimy. 20 feet

Anoplotheca hemispherica (Sowerby)	Lamellibranchs
Buthotrephis sp.	*Rhynchotrema* sp.
Graptolites	*Rusophycus* sp.
Leptaena rhomboidalis (Wilck.)	*Orthis* sp.
Beyrichia lata Hall	Worm tracks.

(Interval without exposure, corresponding to a thickness of 15 feet)

E 2 ; — (In small abandoned quarry.) Tough red sandstone in layers 2–6 inches thick. Surfaces very smooth, indicating abrupt cessation of deposition). It contains a few small fragments of *Lingula*, and shows fucoids on the water-worn surfaces, next to E 3. (Fig. 3) 5½ feet

E 3 ; – Thin bedded shaly, arenaceous, green shale; barren except for a few fucoids. 6 inches

E 4 ; — Friable barren conglomerate, of pebbles which are mostly less than half an inch long, chiefly of quartz, with some elongated black ones, and considerable intermingled sand. The cementing material has the appearance of a dried shallow-water slime. The surface seems to have been dried, coated with slime and eroded by water before subsequent deposition took place. 1 foot 6 inches

E 5 ; — Green shales with thin sandstone beds. 30 to 40 feet. The shales contain

Anoplotheca hemispherica (Sowerby)	*Buthotrephis* sp.
Beyrichia lata Hall	Lamellibranchs.

E 6 ; — Hard grayish green sandstone, somewhat micaceous, barren. 6 inches

E 7 137; — Irregular crushed layer similar to E 5, in places over E 6 barren. 2–8 inches

E 8; — Lower red oolitic iron ore bed,[a] no fossils found. 1 foot 7 inches

E 9; — Upper bluish green shales, with frequent sandstone lenses. Surfaces covered with a slimy enamel. Below the dam the shale contains Orthids and fucoids; above the dam the following

Anoplotheca hemispherica (Sowerby)
Atrypa reticularis (Linn.)
Atrypa (?) *gibbosa* Hall
Buthotrephis sp.
Calymene clintoni Vanuxem
Camarotoechia (?) *neglecta* Hall
Beyrichia lata Hall.
Chonetes cornutu Hall
Cyclonema cancellatum Hall
Cyclonema cancellatum Hall
Crinoidal columns
Dalmanites limulurus Hall
Dalmanella elegantula Dalman.
Leptaena rhomboidalis (Wilck.) (common.)
Lamellibranchs (imperfect.)
Rhipidomella circulus Hall
Orthoceras sp. 35–40 feet

E 10) Upper red oolitic iron ore bed[b]. Forms the upper layers at the water fall. No fossils found. 2 feet

E 11) Gray sandstone, weathering blue gray, above the ore bed; extending to the meadows. *Cruziana* (*Rusophycus*) *bilobatus* Hall[c] abundant in the upper part. 30 feet

E 12) Same? Isolated outcrop of dark gray, very fine grained tough sandstone, with conchoidal fracture, no fossils.

Unless the latter outcrop is the one referred to, nothing could be found of the beds of the Onondaga salt group referred to by Vanuxem ('42 p. 85) as occurring in this field.

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a Smyth ('92) proves that the ore of the lower beds at Clinton, which is about 5 miles distant, is truly concretionary and is in all cases a mass of concentric shells of ore around a nucleus of quartz, it being possible to dissolve away the former with hydrochloric acid leaving the latter. The number of concentric layers of ore is often ten or more. The quartz-sand grains are evidently derived from granitoid or schistose rocks. *See also* Chester (81)

b Locally called the "red flux" bed.

c Prof. J. W Dawson ('64) suggests that *Cruziana* (*Rusophycus*) *bilobatus* Hall, of the New York Clinton, are the casts of the tracks of trilobites; however in this case no trilobite of sufficient size to produce such tracks could be found. Dana ('95) refers them to sea-worm tracks.

The Swift creek section is referred to by both Vanuxem and Emmons, but their accounts are so scattered in different paragraphs through their writings that it is impossible to gather an idea of the section as described by them, until one has visited the locality, and so familiarized himself with it as to be able to piece together their several accounts. For the purpose of comparing the early work done by them with the foregoing description of the section, I have condensed, arranged and correlated the paragraphs of their descriptions, as follows. These show at a glance our previous knowledge of the section, and the field numbers of the foregoing section introduced, facilitate the comparison.

Vanuxem ('42 p. 84) says that "one of the best localities for observing the Clinton group is on Swift creek, which flows by the side of Rodgers' machine factory into Sauquoit creek." His account (l. c. p. 83, 84, 85, 77, 91, 96) together with that of Emmons ('43 p. 146 and 151) may be summarized as follows:

The *Oneida conglomerate* is not visible. It appears however on the road from Utica to New Hartford, at Mason's quarry. It also forms the point of the hill to the southeast of the Mohawk river and Sauquoit creek, New York Mills. The rock is a variable mixture of sand and quartz pebbles, solid and somewhat friable, white, yellow or pink; dip nearly horizontal; divided into irregular layers. The *Frankfort slate* upon which it rests may be seen at several points on the hillside south of the quarry, beneath the conglomerate.

Of the *Clinton stage*, 94 feet are exposed in the Swift creek section.

1) A series of green shales and thin-bedded sandstones with fucoids occurs between the factory and the ravine. (Field number E 1.)

2) Sandstone in small quarry, presenting fucoids and other bodies in relief. (Field numbers E 2 & 3.)

3) Conglomerate of small pebbles of red and white quartz, with some elongated black ones. Surface presents a series of short curves as if water worn. (Field number E 4.)

4) Shale above the sandstone in the quarry, making the third mass in the series. Contains *Beyrichia lata*, etc. 30–40 feet (Field number E 5.)

5) Hard greenish gray sandstone on top of the shale. 14 inches
(Field numbers E 6 & 7.)

6) Lower ore bed, highly oolitic, no fossils. 1 foot
(Field number E 8.)

7) Greenish blue shale, with thin layers of the same colored sandstone; surfaces covered with fucoids. 20 feet
(Field number E 9.)

8) Second ore bed, less pure than the lower one, owing to admixture of limestone, calcareous and silicious shale and slate, oolitic and encrinal. (Field number E 10.)

The mass for a few feet above and below the ore is a mixture of limestone, shale, etc. containing "*Strophomena* (error for *Lingula*?) *clintoni*" (may be a synonym for *Dalmanella elegantula*). *Leptaena rhomboidalis*, etc. 2 feet
(Field number E 9.)

9) Greenish blue shale and slate, with similar darker colored sandstone. Contains in upper part very large *Rusophycus bilobatus*, most numerous in the thin layers. (Field number E 11.)

The remaining parts of the group are not well exposed; the sides of the creek are low, the ground becomes level and loose material is abundant. Finally, on the same creek, near the road from Sauquoit creek to Paris hill appears:

10) Red (Clinton) shale, well exposed in the road.

11) Blue or greenish shale, which disappears eastward. No fossils. 20 feet

12) The *Niagara* appears after the latter, on the same road. It is a dark, concretionary mass, 4 to 5 feet thick. The concretions form segments of large flattened spheres, and may be split into tables a yard square or more. They contain cavities filled with calcite. The concretions are inclosed in shale of the same dark color. Westward the rock becomes purer and loses its concretionary character in part.

In connection with the break in the stratigraphic series in the swampy field succeeding (8) as above, Vanuxem states (p. 85), that, after the Niagara, is seen

13) The shales of the *Onondaga salt group*, which form the next rise by the side of the creek.

The red shales of the latter group are recorded by Brigham ('88) in the ravines on the north and west of Paris hill in New Hartford.

The section given by Hall ('52, p. 16) and Vanuxem ('42, p. 82) at New Hartford, about three and a half miles north of Chadwick Mills, useful for comparison with the latter, when correlated, is as follows:

The section begins below the quartzose sandstone, (number 6 of our Chadwick Mills section), "and consequently is between 60 and 10 feet below the top of the group, as nearly as can be ascertained."

1) Oneida conglomerate.

2) (Blackstone and Davis' quarries at head of Sylvan glen.) Alternating layers of shaly sandstone and conglomerate with shale. 6 or 7 feet of dark gray or red sandstone occur at the base of the quarries, none of the layers, except the upper, being over 6 or 7 inches thick and some but half an inch thick, and separated by or coated with shale, which is blue when fresh, becoming yellowish. (Same as E 2 in the Swift creek section.) Lower surfaces covered with *Rusophycus bilobatus*, most numerous on the thin layers, also other fucoids, *Platystoma*, *Avicula rhomboidea*, *Buccania trilobata*, *Beyrichia*, *Pyrenomoeus cuneatus*. The whole of these fossils is replaced with hydrate of iron. The sandstone is covered with shale of a yellowish green color 8 to 10 feet thick in very thin, leaf-like divisions, which is apparently non-fossiliferous.

   The upper layers consist of small pebbles of white or pink quartz, with some elongated black ones. Upper surface water-worn. Same as 3 in the Swift creek section. Total thickness, about 25 to 30 feet

   (Slope without outcrops) 20 or 30 feet

3) (Wadsworth's ore pits) Upper portion shaly, lower a thin-bedded sandstone, with wave lines and ripple marks. *Pyrenomoeus cuneatus*, *Beyrichia lata*, *Buccania trilobata* and fucoids. In the shale which covers the ore lighter colored arborescent markings are seen, which may be due to moisture, organic origin or decomposition. About 15 feet

4) Shales and shaly sandstones, with *Buthotrephis*, *Beyrichia lata*, etc. and iron ore beds.
(Slope without outcrops) 20 feet

5) (Gaylord and Norton's quarries.) Hard, siliceous and silico-calcareous layers alternating with shale, abound in fucoids. Same as 8 in the Swift creek section. The specimens of *Rusophycus bilobatus* in these beds are of notably large size. 15 feet

137 D; — Stream crossing road near Chadwick Mills on the road to Norwich Corners,— a small branch of Sauquoit creek.

D 1; — Thin bedded shaly gray limestone with quartzite bands three inches thick and shaly partings. Fossils on the shaly surfaces, clearly showing their slime and mud encrusted character of deposition.
Crinoidal plates Bryozoa.
Fragments of trilobites. 10 feet

D 2; — Conglomeratic impure red ore bed, with segregations 2 feet

D 3; — Conglomerate; very tough and often almost a red quartzite. 3 feet

D 4; — Coarse gray limestone with fossils 2 feet+
Leptaena hemispherica Crinoid columns
(Drift covered space intervenes between D4 & D5)

D 5; — Tough limestone in three-inch layers. Some layers shaly, others very ferruginous. 12 feet
Crinoidal columns *Cyclonema* sp.
Rafinesquina corrugata *Rhynchonella* cf. *neglecta*
Homalonotus sp. *Avicula* cf. *emacerata*
Strophomena subplanum
(Intervening 10 feet of strata covered by drift)

D 6; — A gray calcareous conglomerate containing large water-worn clay pebbles, quartz pebbles, calcite and pyrite. Some of the pebbles appear to be of volcanic origin. The rock abounds in Monticuliporid corals, which are well preserved and are of a red color in contrast to the mass of the rock. A species of *Discina* also occurs. 4 inches

D 7;—Hard barren grits overlying D6. 4 feet

D 8;—Hard thin sandy layers and red quartzite, with intercalated blue shale. Fossils on the weathered surfaces only, as in D1,—there numerous. 10 feet

Leptocoelia hemispherica — *Murchisonia* sp.
Rafinesquina cf. *corrugata* — *Rhynchotrema* sp. (common)
Meristella sp.? — *Platystrophia lynx*
Rhynchotreta cuneata — *Monticuliporidae*

D 9;—Soft "lumpy" gray limestone, weathering yellow. Surface covered with large ripple marks which bear N 55 W. (Fig. 4.) 4 feet

(Drift covered space.)

D10;—Black shales like the Frankfort shales, barren; in portions sandy and nodular with quartz and calcite. Only partly exposed. Total thickness at least 120 feet

D11;—Light colored flinty rock, separating the shales. 8 inches.

D12;—Thin bedded shales, barren 5 feet
grading into

SALINA?

D13;—Red shales, barren, often ochreous, 20 feet +

SUMMARY OF THE SECTIONS IN THE VICINITY OF FRANKFORT HILL, N. Y.

(See ideal section diagram)

		Field Numbers		Thickness	
CLINTON	Red shales:—barren	137 D 13		20′	
	(Interval perhaps 25′)				
	Green shales:—barren	D 12		5′	
	Flinty limestone	D 11			8″
	Black shales and sandstone:—barren	D 10		20′	
	(Interval probably 20′)				
	Fossiliferous limestones and sandstones	D 5-9		44′	
	(Interval about 15′)				
	Fossiliferous gray limestone	D4—2′	E 11	30′	
	Conglomerate and quartzite	D3—3′			
	Upper ore bed	D 2	E 10	2′	
	Upper green shales, fossiliferous	L 2	E 9	40′	
	Lower ore bed	L 1	E 8	1′	7″
	Gray sandstone		E 6		6″
	Shales and sandstones, fossiliferous		E 5	40′	
	Conglomerate		E 4	1′	6″
	Barren, shaly		E 3		6″
	Lower green shales, fossiliferous	H5; C;	E 1	20′	+
		Min. thickness		225′	6″+
ONEIDA	Sandstone and conglomerate	(H 4 ?); K 1-5, G 1-4		16′	
UTICA-LORRAINE	Frankfort black shales and sandstone	H 1-3; A.		160′	

Conclusions

The study of so limited an area as Frankfort Hill affords insufficient data from which to draw conclusions of any very general character. The sections examined, however, show the following noteworthy facts :

First. That the Frankfort slates have a very considerable thickness, and are almost entirely barren of fossil remains. Vanuxem ('40 p. 373) has suggested the presence of saline matter, unfavorable to the existence or development of life, in order to explain the fact "that organic life abounded in the period of the Trenton limestone, and disappeared in the lower part of the Black (Utica) slate, reappearing only in the upper part of the Frankfort slate, leaving a thickness of mud rock of at least 400 feet, comparatively destitute of organic bodies."

Second. That the upper beds of the Frankfort gulf section grade into barren fine-grained sandstones (indicating approaching shore-conditions), which very closely resemble the Medina[a] even if the latter in this locality be represented chiefly by the coarse conglomerates of beach deposits of the Oneida, with its coarser interbedded sandstones and occasional intercalated dark layers of shale.

Very abrupt shoaling to the Oneida phase took place with strong currents and the conditions of the wash of a beach. (Hall '83 p. 45.)

Third. There followed a series of alternations between beach and mud-flat conditions, not at all unlike those in progress along the inlets of the New Jersey shore to-day. The result was the complex series of Clinton beds to which Vanuxem ('38 p. 284) gave the name "Protean group," stating its thickness as 200 feet. Our measurements make the thickness a little greater than this. The Clinton fossils of nearly all the layers, especially of sections D and E of the Chadwick Mills section, have a slimy coating upon their surfaces, which it is almost impossible to remove. The surfaces of the slate and the irregular partings likewise partake of this slimy appearance. There is evidence of quick deposition, similar to that of the Jurassic, while the existing land was evidently in the nature of mud and sand flats, washed by sluggish

a On changes of level affecting sedimentation and on cycles of deposition see Dawson '66 p. 102 and '78 p. 135-138; Giekie '82 p. 484; Hunt '63 and '74; Newberry '73, '74, '74a and '75; Dawson '83 p. 96.

currents, and very little affected by tides or other disturbances, inasmuch as crustacean tracks and mud cracks were not obliterated. The surface constantly shifted, however, and the yielding mud of one deposition partially hardened in the sun before it received the next layer of accumulation. The abundance of *Buthotrephis* and other seaweeds, indicates nearness to shore. The fossils of several strata occur principally on surfaces or partings of the shaly layers, indicating landlocked bays occasionally invaded by high tides. Local deposition of sand and gravel took place at intervals. Some of the pebbles have the appearance of materials of volcanic origin (137D6). At about the period when the latter appear, clear water conditions seem to have existed long enough to permit the growth of small corals (E 2–4), which may have been suddenly destroyed by a volcanic eruption. The character of the fauna is shown to be quite constant, so that it is not easy to define good faunal zones, although the materials deposited vary considerably. Foerste ('85 p. 656) says that in Ohio the Clinton deposits were made in valleys and gullies washed out of the Cincinnati group strata. The wastings of an otherwise shallow sea were then very irregularly deposited near the shore line, giving fine silts at a distance from land, with comparatively even deposition, while near the shore the deposits of all sorts would accumulate in the pre-Clinton depressions of the sea bottom.

As a rule the strata studied in this paper are not calcareous. Toward Rochester, deeper water conditions prevailed with deposition of the limestones containing *Pentamerus* (Fairchild '94) which is lacking in the district studied.

As stated by Smyth ('92) the southwest dip of the strata is so slight as to be hardly noticeable at the exposures.

With the possible exception of the outcrop at 137 D 15 which, judging solely from its position and color, may be the Onondaga, no strata above the Clinton were found in the area.

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DESCRIPTION OF PLATES

Fig. 1 Lyon Falls. The falls at the pulp mill, from which the town takes its name. They descend over the gabbro. Locality, 143A. (See p. r26)

Fig. 2 Portion of the bed of Dry Sugar creek, near Boonville, showing the pot-holes in the Black river strata and their enclosed boulders. (Locality 140A1.) (See p. r28)

Fig. 3 Swift creek (Robinson glen) section, Chadwick Mills. West side of Frankfort Hill. Strata of bed 137E2 and 3 rise on either side of the creek.

Fig. 4 West side of Frankfort Hill. Stream near Chadwick. (Section 137D). Showing ripple marks on surface of Clinton bed 137D9. The grooves on the surface here shown are nearly parallel and bear N 55° W. (See p. r44)

Fig. 5 Fall on Sugar river at Leyden (Talcottville). Over the Trenton limestone. Section 141C. (See p. r33)

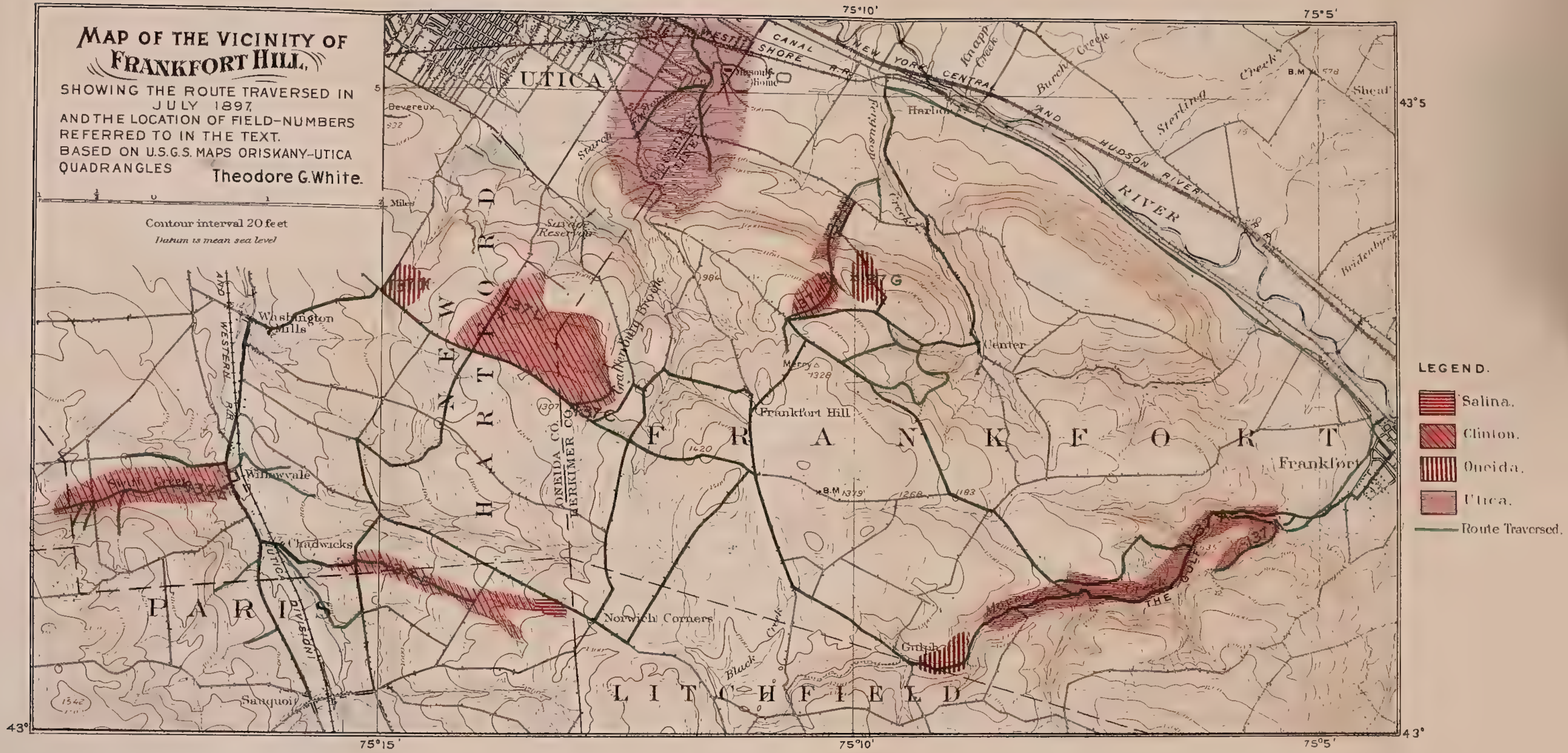
Fig. 6 Moyer creek, Frankfort. East side of Frankfort hill. Frankfort shales at the locality 137A1. Bridge on the farm-road shown on the map and referred to on p. r34, appears in the background.

Fig. 7 Frankfort slates on north side of Frankfort Hill, at one of the water falls on the west branch of Ferguson creek. Beds 137H 1 to 3. (See p. r36)

Fig. 8 A lower fall in the same locality.

KEY TO LOCALITY NUMBERS

Section numbers	LOCALITY	Formation	Described on page
130 A and B.	Rathbone brook, Newport	Trenton	r29
130 D.	Prospect	Trenton	r31
133 A.	Hinckley	Trenton	r32
133 B.	Grant	Trenton	r32
134.	Ohio, Mount creek	Archean	r25
135.	Ohio, Mount creek	Archean	r26
136.	Northwood	Archean	r26
137 A.	Frankfort, Moyer creek	Frankfort slates	r34
137 C.	Frankfort Hill, Graffenberg brook	Clinton	r37
137 D.	Chadwick Mills on a branch of Sauquoit creek	Clinton, etc	r43
137 E.	Chadwick Mills, Swift creek	Clinton	r37
137 G.	Frankfort Hill, west side	Oneida	r36
137 H.	Ferguson creek, west side of Frankfort hill	Utica to Clinton	r35
137 K.	West side of Frankfort hill	Oneida	r36
137 L.	West side of Frankfort hill, Jones quarry	Clinton	r37
138.	Forestport	Archean	r26
139 A.	Hawkinsville	Trenton	r32
139 B.	Hawkinsville	Archean	r33
139 C.	Hawkinsville	Trenton	
140 A.	Boonville	Black river and Trenton	r27
141.	Constableville	Utica-Hudson	r33
141 C.	Leyden. (Talcottville)	Trenton	r33
142 C.	Port Leyden	Archean	r26
142 A and B.	Port Leyden	Black river	r29
143 A.	Lyon Falls, pulp mills	Archean	r26
143 B and C.	Lyon Falls, Moose creek	Archean	r26
143 D.	Lyon Falls, Black river	Archean	
143 E.	Lyon Falls, hill escarpment	Black river	r29


MAP OF THE VICINITY OF
FRANKFORT HILL,
SHOWING THE ROUTE TRAVERSED IN
JULY 1897,
AND THE LOCATION OF FIELD-NUMBERS
REFERRED TO IN THE TEXT.
BASED ON U.S.G.S. MAPS ORISKANY-UTICA
QUADRANGLES
Theodore G. White.
Miles
Contour interval 20 feet
Datum is mean sea level
75°10'
75°5'
75°15'
43°5
43°
UTICA
NEW HARTFORD
FRANKFORT
PARIS
LITCHFIELD
ONEIDA CO.
HERKIMER CO.
Washington Mills
Willowvale
Chadwicks
Sauquoit
Norwich Corners
Frankfort Hill
Frankfort
Center
Gulph
Harbor
Devereux
Savage Reservoir
NEW YORK CENTRAL AND HUDSON RIVER R.R.
WEST SHORE R.R.
CANAL
RIVER
Sterling Creek
Burch Creek
Knapp Creek
Black Creek
THE GULF
LEGEND.
Salina.
Clinton.
Oneida.
Utica.
Route Traversed.

MAP OF THE PRECAMBRIAN BORDER IN ONEIDA & LEWIS COUNTIES SHOWING ROUTE FOLLOWED IN 1897 BY THEODORE G. WHITE.

Scale of Miles

1 ½ 0 1 2 3 4 5

APPENDIX B

SOME HIGHER LEVELS

IN THE

POSTGLACIAL DEVELOPMENT OF THE FINGER LAKES

OF

NEW YORK STATE

A thesis presented to the faculty of Cornell university for the degree of doctor of philosophy

By Thomas L. Watson

INTRODUCTORY NOTE

Around the shores of Lakes Cayuga, Seneca and others of the Finger-lake group of central New York, are various terraces, clinging to the hillsides and standing at different levels. These are so pronounced that they are among the first features to attract the eye of the geologist who enters these valleys. Almost as soon as I came to Ithaca in 1892, I saw plainly, what others had previously noted, that these terraces represented former water levels. Their form and structure was clear proof of this. It seemed to me that there was here a very nice problem for student work; and while I have made numerous observations in the district since first coming to it, no attempt has been made by me to work out the lake history in detail. At first the size of the problem was not fully understood, and in 1892 Mr J. B. MacHarg jr, did some work upon it, but reached no definite results. Later, in the autumn of 1893, and the spring of 1894 a senior at Cornell university, Mr R. F. Livingstone, undertook the study of some of the lower shore lines and wrote his graduating thesis upon this subject under the title, "Origin of the Cayuga valley terraces."

This is now deposited in the library of Cornell university. Other students have also done some work upon parts of the problem.

In 1894 Dr Watson undertook the investigation of these terraces as graduate work leading toward the degree of doctor of philosophy, finishing the field work in the spring of 1897. So far as the general results of this work are concerned, a supervision of the work which he undertook satisfies me that Dr Watson has brought out some very valuable results. This supervision also leads me to accept all of the details of observation, though of course I have not attempted to verify each of them. That he has not finished the investigation is no fault of his. The solution of the entire question reaches far beyond the district of the two larger Finger lakes, and to work out the full history might very likely mean the study of a large part of the Great Lake history. As it stands, Dr Watson's paper constitutes a distinct contribution to the Pleistocene history of central New York.

RALPH S. TARR

Cornell university, Ithaca, N. Y.

MARCH 8, 1898

Acknowledgments

To Professors R. S. Tarr, A. C. Gill, and G. D. Harris, of the geological department of Cornell university, the author wishes to express his obligation and appreciation for the interest manifested in his work while a student in the university. To Professor Tarr, under whose kind direction this investigation was undertaken, he is specially indebted for constant invaluable suggestions.

T. L. W.

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MAPS

Introduction

The Finger-lakes[a] of the central western New York plateau are too well known to American geologists to admit of any very lengthy introductory statement. It was one of the first regions in the state to receive attention from the earlier workers. The origin of the lakes was touched upon at the very beginning of geological survey work in New York state, more than 50 years ago, when the glacial hypothesis had not been clearly expounded. Not only was their origin referred to but as early as 1842, Vanuxem,[b] after a study of the loose deposits of gravel, sand, earth etc., found along some of the valley sides, especially in the region about Ithaca-stated that these lakes had formerly maintained higher levels. He says, " Some of these deposits greatly resemble the hills of loose materials which rise in the valley near Fall and Cascadilla creeks when the lake was at a higher level; for where such substances are deposited in deep and tranquil waters, there is no tendency to diffusion; the head of the lake upon which Ithaca is seated, being a perfect flat."

" There are numerous points where the alluvium appears to have been formed over the hill side, besides those near the mouths of the creeks near Ithaca." Since the writings of Lardner Vanuxem and James Hall numerous contributions have been made on the different phasal aspects of the Finger-lake geology, but so far as known to the writer, only one geologist has published upon the supposed higher levels of these lakes.

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a The dimensions, including length, average width, maximum depth, and elevation above sea-level of the present lakes are here appended for the sake of reference. These data were kindly furnished by Professor C. L. Crandall of the College of civil engineering of Cornell university and taken from the Cornell university lake surveys.

NAME OF LAKE	Length in miles	Average width in miles	Maximum depth in feet	Height above sea level in feet
Canandaigua	15.6	1.1	258	687
Keuka (or Crooked) lake	16.9	0.7	179	718
Seneca	34.2	2.0	612	441
Cayuga	37.6	1.9	432	378
Owasco	11.1	1.0	177	703
Skaneateles	15.5	0.9	297	858

b Natural History Survey of New York—Geology—Third District, by Lardner Vanuxem, 1842, p. 219.

During the spring of 1895 Professor H. L. Fairchild[a] spent a short time in the study of their supposed higher levels, and his results were published in the "Bulletin of the geological society of America."

Most geologists who have visited the region about Ithaca and Watkins, have been attracted by the occurrence of the supposed delta terraces along the lower portions of the valley sides, where the tributary streams enter, and have doubtless surmised their significance.

When the present study was first begun, it was intended to restrict it to the lake sequence in the Cayuga and Seneca lake valleys. But, after working out the higher local stages in these two valleys and studies begun on the next lower, it soon became evident that the order of events in Cayuga and Seneca lake valleys could not be isolated from that in the other members of the Finger-lake series. Hence, for a territory so large and extended, time has been insufficient to complete the entire post-glacial lake history of the Finger-lakes, but has, I believe, proved ample for tracing out and establishing some of the higher levels.

Preliminary considerations

Topography of the Finger-lake region.[b] Almost without exception, all previous writers have described the Finger-lake topography, and to enter into a detailed description at present, would simply mean a restatement of what has been previously stated many times over by others, without adding any special value or merit to the present work. In view, therefore, of what has already been done, only a very general outline of its topography will be attempted, such as is deemed necessary to an adequate understanding of what follows in the subsequent part of this study.

The New York-Pennsylvania plateau has been referred to as the New York extension of the northernmost Appalachian plateau, in which the valleys of the present lakes distributed throughout the central New York region have been deeply incised. All the lakes

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a Bull. geol. soc. Am., 1895, 6, 353–374.

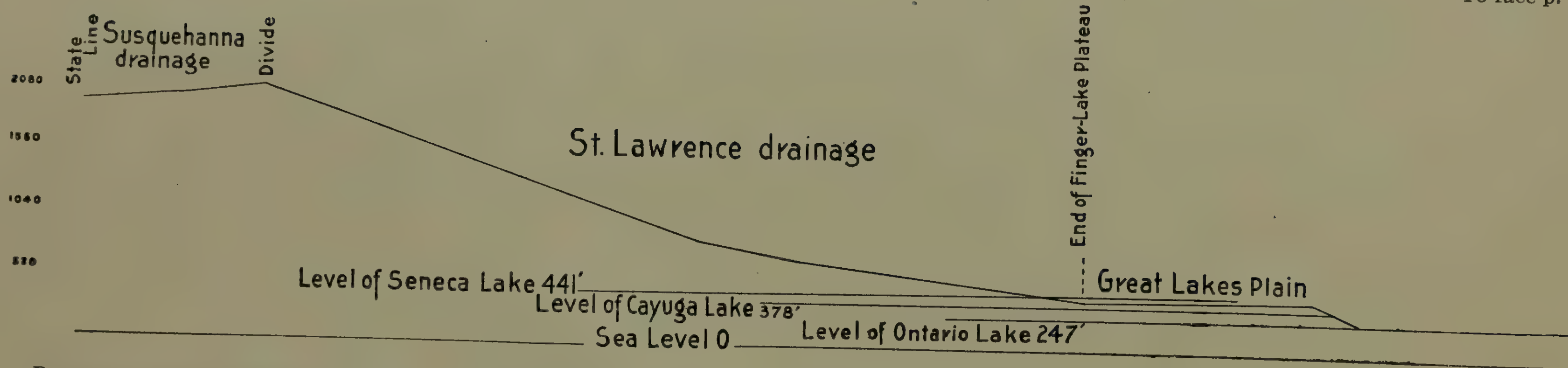
b Mather, Geology of New York, Part 1, 1843, 317–365.

Hall, J., Ibid Part 2, 1843.

A further description may be had by referring to most of the appended references in the bibliography.

FIG. 1.

To face p. 67.



PROFILE TAKEN ALONG THE CREST OF THE DIVIDE BETWEEN LAKES CAYUGA AND SENECA, ILLUSTRATING THE NORTHWARD SLOPE OF THE FINGER-LAKE PLATEAU AND ITS RELATION TO THE GREAT LAKES PLAIN.

have free drainage to the north and occupy distinct preglacial valleys. Lakes Cayuga and Seneca, the two largest of the series, have their bottoms considerably below sea level. The rocks are almost wholly Devonian in age and consist principally of interbedded shales, sandstones and limestones, with an almost horizontal attitude, though having a slight but perceptible general southerly dip. In the Cayuga lake region the rocks have suffered more disturbance, and are thrown into very gentle folds,[a] whose axes are approximately east and west; or, at right angles to that of the lake.

Located some 12 to 15 miles from the heads of the lakes, is an irregular divide, which has been best described by Professor Tarr[b] as being "high and diverse in topography", separating the Chemung-Susquehanna tributaries on the south, from the southern tributaries of the St Lawrence system on the north. At the divides of the lake valleys is found the "Terminal moraine of the second glacial epoch" as traced, mapped and described by Professor Chamberlin.[c] Its position on the hill-tops is marked at the following points: Bristol, 2254 feet; Virgil, 2133 feet; Urbana, 1940 feet; Orange, 2033 feet; Newfield, 2095 feet; Dryden, 1888 feet; Solon, 1977 feet; Fabius, 2015 feet; Fenner, 1862 feet.[d]

Broadly speaking, the plateau may be regarded as extending from the Catskill mountains on the east to Chautauqua county on the west and merging into the "Great Lakes shore plain"[e] on the north, with a very strongly defined northern slope throughout (Figure 1). The highest elevations found over many of its parts reach 2000 feet and over, with a general average elevation of approximately 1200 feet above sea level. Dr Lincoln[f] has described the plateau as being axially depressed along the Cayuga-Seneca region in a north and south direction, which he illustrates by a diagram.

The Finger-lakes proper may be regarded as extending from Otisco lake on the east to the Genesee river on the west; or, as

a Williams, H. S., Bulletin no. 80, U. S. G. S., Washington, 1891.
Ibid. Proc. Amer. asso. adv. sci., 1882, 31, 412. This one especially.
b Tarr, R. S., Bull. geol. soc. Am., 1894, V. 340.
c Chamberlin, T. C., Third ann. report, U. S. G. S., 1881-'82, 295-402.
d Triangulation of New York state survey, 1883, 1887; also, see Lincoln, D. F., Am. journ. sci., 1892, 44, 290.
e Tarr, R. S., Bull. Am. geogr. soc., 1896, 28, 106-107, 111.
f Lincoln, D. F., Am. journ. sci., 1892, 44, 290-293.

Brigham[a] states, we may include Chautauqua the most western lake in the state and regard the whole as the Otisco-Chautauqua series. However, when the Finger-lakes are referred to, the limits in the first statement are regarded as being essentially correct. The present study includes only the series of lakes that find drainage through the Seneca-Oswego river; or, from Honeoye lake on the west to Skaneateles lake on the east. Generally speaking, the lakes are approximately parallel in the direction of their longer axes, which trend north and south; but, more accurately speaking, they converge toward a common locus, in the Canadian territory, just north of Lake Ontario. The entire series, in which more than a dozen lakes are included, is drained by two streams tributary to the St Lawrence system. The most westerly ones find drainage into Lake Ontario through the Genesee river, while the remaining and most easterly ones are drained through the Seneca-Oswego river, which enters Lake Ontario considerably east of the Genesee. Lakes Cayuga and Seneca drain through the latter channel, emerging as very sluggish waters, and meandering through a large area of low and swampy land. This is especially true of the Cayuga outlet. The side streams entering the Finger-lakes are characterized by waterfalls which in some cases are of considerable height. The stream gradients are prevailingly steep for the middle and southern portions of the valleys, but become very much less precipitous as the lake outlets are approached.

Direction of flow of the streams occupying the valleys of Lakes Cayuga and Seneca in preglacial times

Preglacial Cayuga and Seneca were argued by some earlier writers to be occupied by south flowing streams, and were given as tributaries to the Chemung-Susquehanna drainage. The later writers, almost without exception, have believed them to be north flowing, entering as tributaries to the St Lawrence system.

One has only to visit the divide region parting the waters of the two systems, to be convinced that it is a case of head-water erosion forming a most typical system of interlocking drainage. It can hardly be doubted that the Laurentian tributaries were the stronger streams and therefore encroached upon the territory of the other

a Brigham, A. P., Bull. Am. geogr. soc., 1893, p. 25, 4.

system, thereby causing a southward migration of the divide. The attitude of the strata favors such migration and represents a case of monoclinal shifting of the divides.

Many facts could be brought forward favoring the northward flow, but a statement of the leading ones[a] will suffice, which are: first, the general and pronounced slope of the country to the north, which is evidently a preglacial slope; second, the vast amount of glacial filling required in the valleys south of the lakes, if south flowing; third, that the valleys open out quite uniformly to greater widths northward, starting from the divides in the southern portions of the respective valleys, where the width will probably average from three-quarters of a mile to one mile, with very steep, rugged and precipitous sides, a mature condition though strongly accentuated. Proceeding northward from the divide, the valleys gradually but perceptibly, widen out more and more, and their sides become lower and more rounded until they merge into and are replaced entirely by the "Great Lakes plain" to the north.

Professor Tarr[b] has brought forward one of the strongest points yet made favoring the northward flow in the preglacial Cayuga valley. His evidence is based upon the height of the rock floors in the creek valleys of the preglacial tributary streams entering the Cayuga lake valley with reference to the present lake-level. In the case of Six Mile creek, the entrance to preglacial Cayuga is found to be 50 feet above the present lake level. Salmon creek, which is some seven miles north of Ithaca, entered about 30 feet above lake level, while at Union springs, some 20 miles north of Salmon creek, its entrance in preglacial times was below the present lake level. The evidence in this case is apparently so confirmatory, that only one conclusion can be drawn, namely, that Lake Cayuga valley was occupied by a stream with a well established northward gradient and therefore tributary to the Laurentian river system.

Again, in the case of Lake Cayuga, the engineering department of Cornell university has issued a map which shows 223 lateral streams

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a Brigham, A. P., Bull. geogr. soc. Am., 1893, 25, 10–12.

Chamberlin, T. C., Third ann'l. report, U. S. G. S., 1881–'82, 335.

Lincoln, D. F., Am. Journ. Sci., 1894, 47, 105–113; Read before the Madison meeting Am. asso. adv. sci., 1893.

Tarr, R. S., Bull. geol. soc. Am., 1894, 5. 352–354.

b Tarr, R. S., Bull. geol. soc. Am. 1894, 5, 339–356.

entering the lake, with only 13 of this number entering the northern third of the basin. The majority of the total number of tributaries, however, are very small and distinctly post-glacial throughout their courses, but all of the larger ones which have been traced as preglacial, enter the southern half of the basin, and not one can be shown to have entered near the outlet part of the valley. This is entirely in harmony with a normally developed north flowing stream.

The evidence for north versus south flow for the preglacial Cayuga and Seneca valleys can be summed up in the following brief statement; namely, that the entire topography is directly opposed to and inconsistent with a south flow for these streams. The divides have further suffered from the effects of glaciation, just how much, is difficult to state, but the evidence seems not to favor the hypotheses of any very extensive migration from this cause.

Classification of lacustrine deposits

The deposits in glacial lakes away from the immediate shore line are capable of differentiation and classification into two distinct types. In many instances, however, these cannot, with any degree of certainty, be differentiated from each other.

Berg deposits. No portion of the material found within the lacustrine limits has been definitely traced to berg action. Other things being equal, the lake depth during some of the higher levels was sufficient to float bergs of fair dimensions, and it is not unlikely that some of the deposits are due to this cause. There seems to be better grounds for ascribing to this agency some of the boulders distributed over the valley bottoms, rather than any of the finer material, but even in this case, nothing definite can be said, since they might very well have resulted directly from the ice. Unless the deposits were conspicuously marked it would be exceedingly difficult to locate them over the lake floor in the respective valleys, and thereby differentiate them from other deposits, inasmuch as the entire lake extension lies wholly within the glacial limits, and the true glacial drift is very heavy and extensive throughout.

Lacustrine clays and silts. In some parts of the valleys, notably in the southern portions, clays and silts resulting in all probability from lake action, can, I believe, be differentiated. They by

no means, form a regular and uniform covering over the valley bottoms, but on the other hand, mark an irregular covering. Lamination is not always distinct enough to admit of their identification. Where noted, they were made up of dark and light colored sandy loams, grading into coarser material, such as sand and gravel, near and along the valley sides. Numerous sections have been noted in the southern parts of Cayuga and Seneca valleys. Some of the morainal hummocks in the divide region of Cayuga valley exhibit a veneering of lake silt, from their bases up to near the tops.

Location and description of the valley divides and overflow channels. We are concerned chiefly in this study with three of the north and south valley divides. Others have been discovered and will receive full and adequate description in their proper places. The three outlets here referred to and defined are the most important ones, inasmuch as they have not only served to conduct the overflow from as many local and initial water bodies, but two of these also mark the outlets to the largest and therefore, principal lake stages. Hence, they merit a fuller description.

The first one, called the Spencer Summit overflow, is about 15 miles south of Ithaca in the Cayuga Inlet valley, one quarter of a mile north of Spencer Summit depot, on the Lehigh Valley railroad. The second, called the White Church overflow, is some 10 miles southeast of Ithaca in one of Lake Cayuga's main tributaries, Six Mile creek valley, one half to three quarters of a mile north of White Church depot, on the Elmira, Courtland and Northern branch of the Lehigh Valley railroad. The third, called the Horseheads overflow, is approximately 15 miles south of Watkins in the Seneca Inlet valley and just a few rods north of the village of Horseheads on the Northern Central railroad. Each of the three outlets leads over the "Terminal moraine of the second glacial epoch," and in the main, their general characteristics are as nearly identical as is possible to find them. A description of one would almost suffice for either of the remaining two.

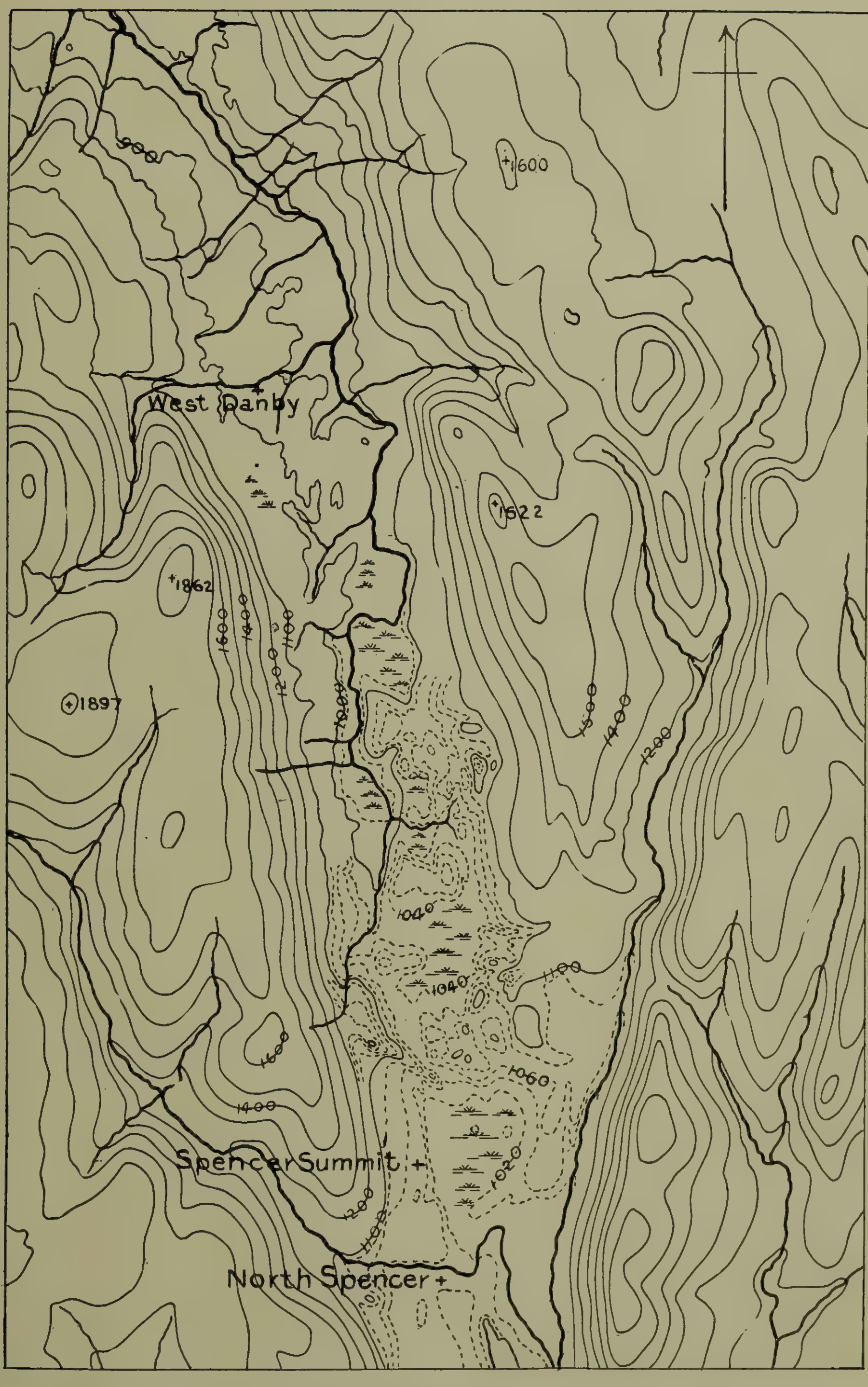
When the ice had advanced to the divide region in the valleys, where is now situated its moraine, a long and protracted halt ensued. The escaping glacial waters, which presumably, were largely subglacial, found ready channels of escape through broad and deeply carved south reaching valleys, tributary to the Chemung-

Susquehanna system. These waters were heavily laden with the material transported by and to the glacier front, which marks the very heavy and extensive deposits laid down throughout the greater lengths of the valleys as valley-trains. Such deposits are rarely seen in a higher degree of development. The divides are not high and sharply defined, but are very low and broad, and replaced almost wholly by extensive swamp areas. From these, the head waters of the north and south flowing streams have their origin, and meander in a most sluggish manner.

Spencer Summit outlet

The divide in the Cayuga Inlet valley is marked by an almost continuous gravel ridge extending across the valley, rising from 75 to 100 feet and more above the overflow channel, which is at the head of a pine forest near the eastern side of the valley. (Figure 3) The Lehigh Valley railroad has cut through the ridge a little west of the middle part of the valley with an elevation of 1074 feet. The bottom of the overflow channel at the head of the forest is 35 feet lower than the railroad elevation, giving therefore for this channel an elevation of 1039 feet above sea-level. The channel, while small, is very pronounced and characteristic, and has been fully and accurately described by Fairchild[a] as follows: "The old stream channel, which once carried the overflow of the glacial waters from the lake north of the divide, is, however, upon the extreme eastern side of the valley, upon the farm of Mr A. Signor. The head of the outlet is at the north border of the only primitive pine forest in the Cayuga basin, at which point the morainic hills fall off steeply to the deep valley northward. The channel runs southeast through the pine forest about 80 rods, then some 40 rods through cleared fields, and then bends abruptly to the east, and in 20 rods reaches the Cattatonk creek, which enters the valley from the north and at this point flows in a rock bed at the very base of the eastern rock-wall of the valley. (Figures 4 and 5) Just before reaching Cattatonk creek the channel crosses the highway close to the house of Mr S. D. Turk. At this point it is about 12 feet lower than at its head in the north edge of the forest. This figure is upon the authority of Mr Signor, who relates

a Bull. geol. soc. Am., 1895, 6, 370-371.



OUTLET OF THE WEST DANBY GLACIAL LAKE
AT NORTH SPENCER, TIOGA CO.

Scale of Miles

1 ½ 0 1 2 MILES

FIG. 3.

To face p. 72.

C. S. Downes, photo.

SECTION OF RIDGE MARKING THE DIVIDE IN CAYUGA INLET VALLEY. ONE-QUARTER OF A MILE FROM SPENCER SUMMIT DEPOT, LEHIGH VALLEY RAILROAD. VIEW LOOKING WEST FROM RAILROAD.

FIG. 4. To face p. 72.

OUTLET CHANNEL OF WEST DANBY LAKE. MIDDLE PORTION OF CHANNEL. VIEW LOOKING SOUTH, AND DOWN STREAM, FROM EDGE OF PINE FOREST. IN THE LEFT BACKGROUND THE CHANNEL TURNS ABRUPTLY TO THE LEFT. (After H. L. Fairchild.)

FIG. 5.

Outlet Channel of West Danby Lake, Mouth of Channel. View Looking East, Showing Sudden Termination of Channel in Cattatonk Creek, which Flows at the Base of the Rock Wall. Point of Ridge at the Right is Rock. (After H. L. Fairchild.)

FIG. 6.

To face p. 73.

ITHACA LAKE, OUTLET CHANNEL AT WILSEYVILLE. VIEW FROM WILSEYVILLE STATION, LOOKING NORTH. AT THIS POINT THE CHANNEL WIDENS. HEAVY FLOOD-PLAIN IS SEEN IN DISTANCE ON WEST BANK. (After H. L. Fairchild.)

THE HORSEHEADS OVERFLOW CHANNEL BY ELMIRA

OUTLET TO GLACIAL LAKES WATKINS AND NEWBERRY

FIGURE 7

Scale 1/62500

Contour Interval 20 feet

Datum is mean Sea level.

that during a flood of the creek in June, 1855, the waters set back up the extinct channel until the water actually fell northward toward Cayuga lake, the flood standing 12 feet high on the buildings by the highway. The channel is from 10 to 15 rods wide, and is the smallest and shortest of the ancient outlets so far seen by the writer."

A number of the morainal hummocks immediately north of the overflow channel rise from 30 to 60 and 75 feet above the outlet and clearly represented miniature islands dotting the surface of this part of the lake, since no lake deposits can be found capping the highest knolls.

White Church outlet

The head of this channel occupies the middle portion of the valley at the Bell school-house some three quarters of a mile north of White Church depot, and is about one quarter of a mile wide, flanked on either side by flood-plains, the highest one of which is 30 to 40 feet above the bottom of the channel. The channel follows directly southward in an almost continuous course to join the Susquehanna river at Owego, some 20 miles distant. The tracks of the Delaware, Lackawanna and Western, and the Elmira, Cortland and Northern railroads are laid near the bottom of the channel and continue in it for some distance southward. The divide over which the White Church overflow leads, is not so sharp and distinct as the Spencer Summit divide. The streams continue in sluggish meanders for a mile or more to the north and south of the water parting. Neither is the moraine so typically developed in this valley, although it is quite distinct and reaches some distance south of the divide when it gradually merges into the heavy valley trains. The divide has an elevation of 973 feet, as given by the survey of the Elmira, Cortland and Northern railroad, with a distance of about one mile between the valley walls at this point.

Horseheads outlet

This overflow, which is a short distance north of the village of Horseheads in the southern part of the Seneca valley, is by far the largest and most perfectly developed channel of the ancient overflows. It is about one quarter of a mile in width at its

head, and the valley in which it is enclosed is somewhere between one and one and a half miles wide in the divide region. As one journeys northward to Pine valley, the channel becomes narrower and less pronounced than at Horseheads, and from this point north to Havana, the moraine has attained a high degree of development, and is even more strongly pronounced than in the Cayuga basin.

Following the channel southward from the divide, it grows wider and wider, until it opens out into one immense plain, over which the glacial waters were conducted into the Chemung river. For most of the distance, the flood-plain terraces have assumed remarkable proportions and are quite prominent and even conspicuous from their characteristic development. Their surfaces are some 20 to 40 feet above the channel bottom on the two sides. The Northern Central railroad finds an easy and good bed along the channel bottom toward Elmira. The bottom of the channel at its head has an elevation of 900 feet. The distance into Elmira is over six miles with an estimated difference in elevation of 40 feet, giving, therefore, a grade of about seven feet per mile. Here again, I give a part of Fairchild's description of this old channel. He says: [a] "The parting of the waters is close to the village of Horseheads, where Newtown creek, draining the eastern highlands, flows south past the village to Chemung river, and Catherine creek heads and flows north to Seneca lake. The true glacial channel, with definite banks and flood-plains, begins at the water-parting some three-fourths of a mile north of the village of Horseheads. (Figures 8 and 9) At this point it is about one fourth of a mile wide with bluffs and two narrow flood-plains 20 to 40 feet in height. For the seven miles to Chemung river the channel has a nearly straight course, with a direction east of south. At its head the channel lies near the west rock-wall of the great preglacial valley. From Horseheads to Elmira its deepest section lies close to the east wall." This channel has an equally slight gradient northward as far as Pine valley where the glacial lake properly began, as to the south into Elmira.

It is strikingly noticeable to see with what remarkable regularity the flood-plains skirting the respective channels in each of the valleys have been constructed. Also, the striking sameness in each;

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a Bull. geol. soc. Am., 1895, 6, 366-367.

FIG. 8. To face p. 74.

Watkins Lake. Channel at Horseheads. View from Lower Flood-Plain South of the Village, Looking North of East, Across the Narrower Deep Channel. The Two Terraces are Clearly Seen on the Opposite Side. Newton Creek in Foreground. (After H. L. Fairchild.)

FIG. 9.

To face p. 74.

WATKINS LAKE. HEAD OF OUTLET CHANNEL. VIEW IS FROM LOWER FLOOD-PLAIN, WEST SIDE, LOOKING EAST OF SOUTH; HORSEHEADS VILLAGE IN MIDDLE DISTANCE; UPPER FLOOD-PLAIN SHOWS AT THE RIGHT. (After H. L. Fairchild.)

the variation being in degree of development which is not very great, and not in kind.

While the various overflows have attained a rather conspicuous degree of development, they have been lowered by erosion but a few feet at most in the soft glacial deposits. The channel-ways seem to suggest a uniform rate of erosion, since the deposits in which they have been sunk are apparently homogeneous throughout and not blocked or interspersed with bowlder belts. In no instance has any portion of the respective channels cut through the till into the underlying shale, with the single exception of a part of the Spencer Summit outlet. This fact tends to lend strength to the argument favoring a short life history for the numerous lake stages among the higher levels of the Finger-lakes. Such a condition might result from an overburdening of the channels. This would be especially applicable to the incipient lake stages, before the ice had withdrawn very far northward from the divide region. From what follows in the subsequent parts of this paper, it would hardly seem that overburdening continued throughout the ice retreat, as the lake extent would certainly modify and check this condition.

Shore features in the finger-lake valleys

Constructional shore-lines. On nearly every one of the streams which was tributary to these valleys in preglacial times is marked a series of well developed delta terraces, the highest ones averaging above the 1000 foot contour. They are found at different elevations from the highest down to those forming at the mouths of the streams entering the lakes at present. In many instances, however, they are absent from some areas, where, judging from present indications, conditions would certainly have favored their development. Why they were not recorded seems difficult to explain, any further than when the waters of the lake occupied that level, the controlling conditions, whatever they may have been, were certainly not favorable or conducive to their formation. In other words, the explanation proposed is conjectural.

The deltas are variable in size, but their mode of formation was the same, as can be seen revealed in their structure. That they are true deltas does not admit of reasonable doubt. Their places of location, relation to the streams, mode of formation and structure

are all characteristic delta criteria. They have level tops, steep fronts and serrated margins; they are delta shaped and built of thoroughly water worn material highly stratified, and when exposed in section by erosion reveal more or less the tripartite structure so characteristic of all delta forms. (Figures 10 and 11) This is the only type of shore-line phenomena which, when considered singly, would afford confirmatory evidence of a past lake. No beaches of even fragile formation were anywhere found. In fact, no other form of constructional shore-line has been seen, save in one or two instances a form which very closely simulates the bar, and has been classed with that type. These terraces will be further considered under the different lake stages.

Destructional shore-lines of wave-cut origin. This type of shore-line is referred to with considerable doubt. Only where correlation with the constructional forms was possible were the terraces in the till deposits considered as probably portion of a wave-cut shore-line. In areas between many of the streams upon which deltas are to be found and where the drift is unusually heavy, benches in the drift and at corresponding delta levels, were traced and possibly may be referred to wave cutting or, some modification thereof. The forms are suggestive, since they not only agree in correlation with the other shore phenomena, which might very well be accidental and ascribed to other causes, but in many instances are strewn with water-worn material, such as sand, gravel and pebbles, common to such forms. The most notable ones are found along the southwest side of Six Mile creek valley, and the west side of the Inlet valley south of Ithaca. They are, also, found on a smaller scale along the east side and the middle southern part of the valley.

Terraces of differential degradation. Owing to differences in lithologic and physical conditions pertaining in the majority of the rock masses of the Finger-lake region, terraces due to differential atmospheric erosion are of frequent occurrence, and in some places are conspicuous topographic forms. These special forms are not restricted to the lake area of the plateau, but, in some places are found in abundance to the south of the divide. At all times they are here characteristic of the most elevated portions of the valley sides. They have in most instances reached a rather advanced stage in development, being continuous for some distance. In several

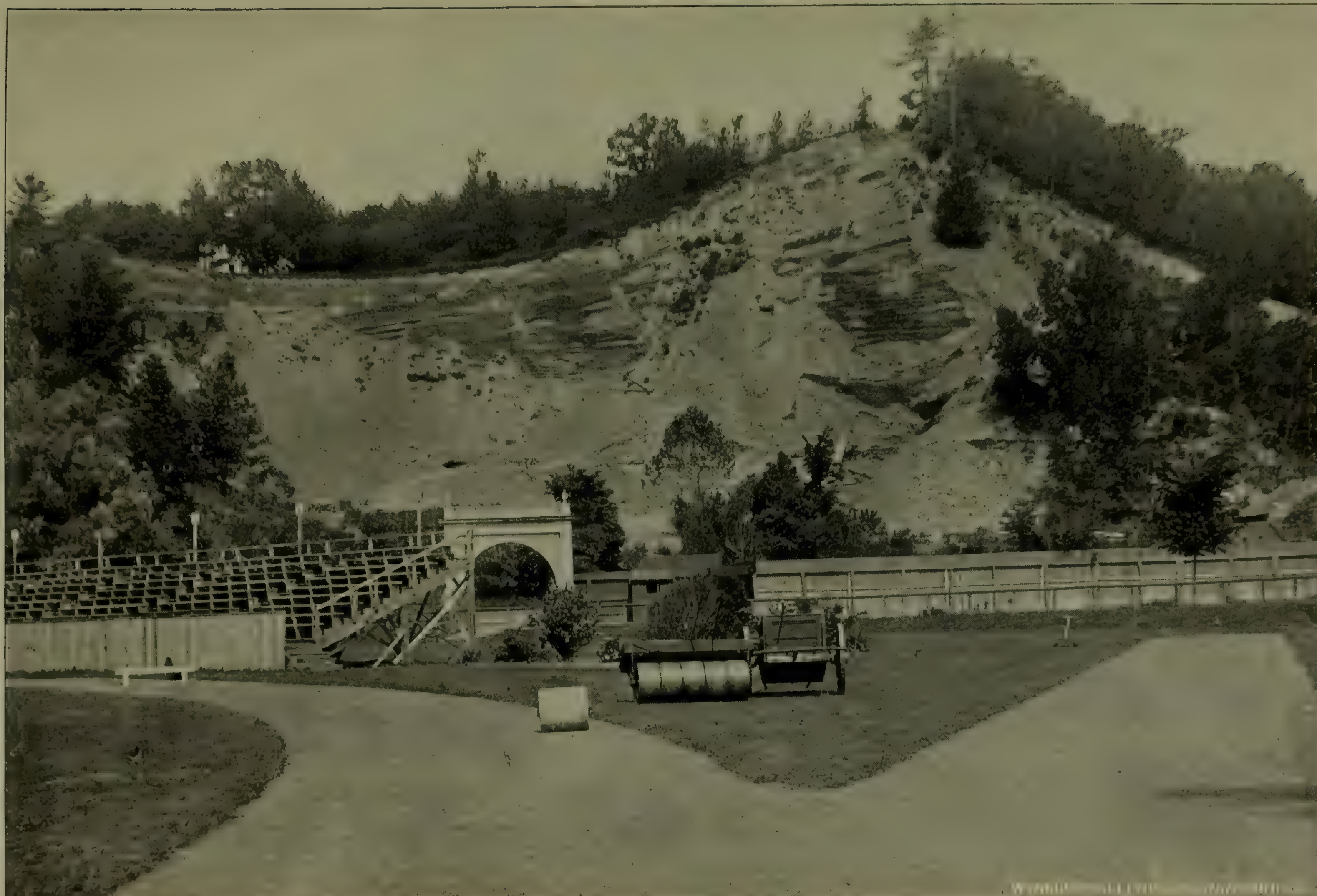
FIG. 10.

To face p. 76.

VIEW OF A SECTION OF THE NEWBERRY DELTA ON WEST BRANCH (NEWFIELD CREEK). NORTH SIDE OF STREAM, LOOKING EAST.

FIG. 11.

To face p. 76.



View of a Section of One of the Lower Deltas on Fall Creek, "Dead Head" Hill. Point of View is Looking East from Percy-Field.

instances this type of terrace has been formed by accident at one or more of the higher lake levels, and by static water modification possibly transformed into a lake shoreline. This is shown along the south side of Six Mile creek, beginning at the east side of the Inlet valley just out of the city limits of Ithaca, and forming the juncture of the two valleys; and, is again marked along the south and east side of Cascadilla creek, which marks the beginning of the divide between Six Mile and Cascadilla creeks.

Statement of the possibilities

During the entire progress of the field work the writer has constantly borne in mind all possible hypotheses by which the conditions might be explained. A large amount of data has been accumulated, which will be stated as we have need for it and will find its proper place in a subsequent part of the discussion. Three and only three, hypotheses have appealed to him as being at all plausible in explaining the facts. They may be stated as follows:

1 The whole or a part of the terraces are glacial or morainal terraces. This hypothesis necessitates the former existence of a glacial tongue, partially filling the valley, against which alluvial deposits were built; a subsequent entire or partial withdrawal of the tongue brings the deposit to the angle of rest, assuming in part the form and outline of a delta. Generally a portion of the terrace material is derived from the glacier.

2 A condition of marginal lakes due to differential wastage of a stagnant ice tongue or lobe, mostly along the ice and land contact.

3 A general lake condition. This hypothesis postulates a northward withdrawal of the ice-lobe, acting as a northern dam or barrier to the north flowing waters and holding them up to the levels of their respective divides, thereby reversing the drainage to the Chemung-Susquehanna system, until the ice had nearly or entirely uncovered the Finger-lake region. Or, as may have been the case in some of the lower stages the outlet was to the north, and was possibly either SUPERglacial or SUBglacial, or, both.

Discussion of the hypotheses

These will be taken up and discussed in the order in which they have been stated.

Morainal terrace hypothesis. This type of terrace has been defined by Gilbert[a] in the following language: "When an alluvial plain or alluvial cone is built against the side or front of a glacier and the glacier is afterward melted away, the alluvial surface becomes a terrace overlooking the valley that contained the ice."

Chamberlin,[b] in his report on the "Terminal moraine of the second glacial epoch," gives the following description of a morainic terrace: "In the deep valleys of the more hilly regions long tongues of ice were thrust forward beyond the common ice-margin, along the sides of which drift terraces seem to have been formed, which, at their upper or ice-ward extremity, take on a morainic character, but at their lower or distal extremity, grade away into a smooth, irregular terrace which either dies away or abruptly ends."

In his report on the "Surface geology in New Jersey," Salisbury[c] has proposed the name kame terrace for the morainic terrace of other glacialists After describing the KAME terrace, he says: "This is essentially the sense in which the term moraine terrace has been used, although the term as heretofore used does not imply the absence or essential absence of motion on the part of the ice."

The material from which this topographic form is constructed may be land-derived or ice-derived, nearly always from the former, and generally, to a greater or less extent, a composite of the two sources of material, inasmuch as both kinds enter into its make up

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a Gilbert, G. K., Lake Bonneville, Monograph 1, U. S. G. S., p. 81. For a complete description see p. 81–83.

b Chamberlin, T. C., Third ann'l report, U S. G. S., 1881–'82, 304.

c Salisbury, R. D., Ann'l Report New Jersey geol. surv for the year 1893, p. 156; also consult,

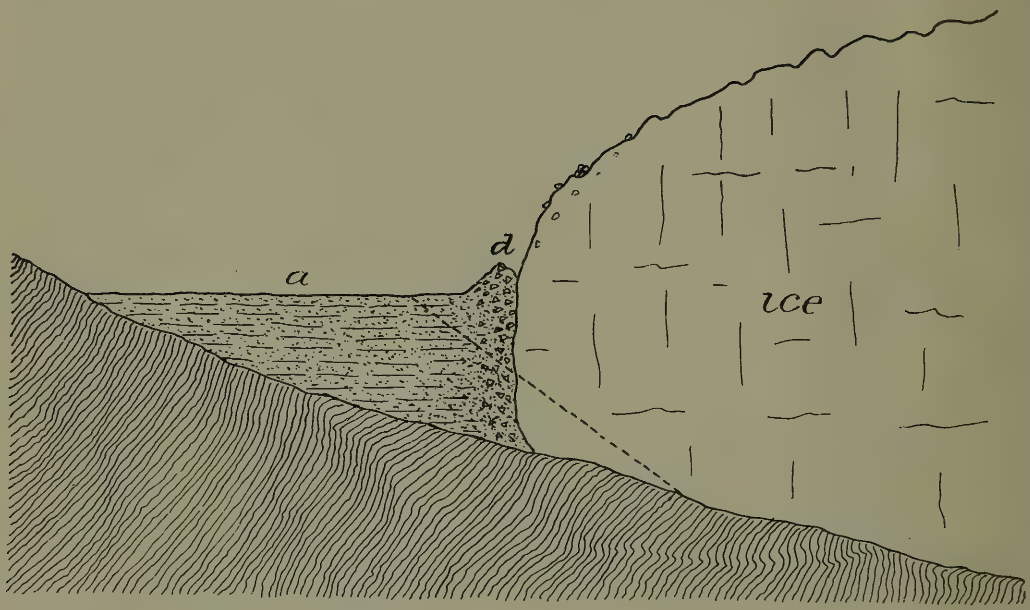
Hitchcock, E., Smithsonian contr. knowl. Vol. 9, p. 6, 33 This is not the true moraine terrace as described by later writers.

Jamieson, On the last stage of the glacial period in Great Britain. Quart. journ. geol. soc. (London), 1874, 30, 333. The author gives a cut illustrating the formation of lateral moraine terraces formed by a retreating glacial lobe. Reproduced from

Miller, Hugh, River terracing: Its methods and their results. Read before Roy. phys. soc., March 24, 1883.

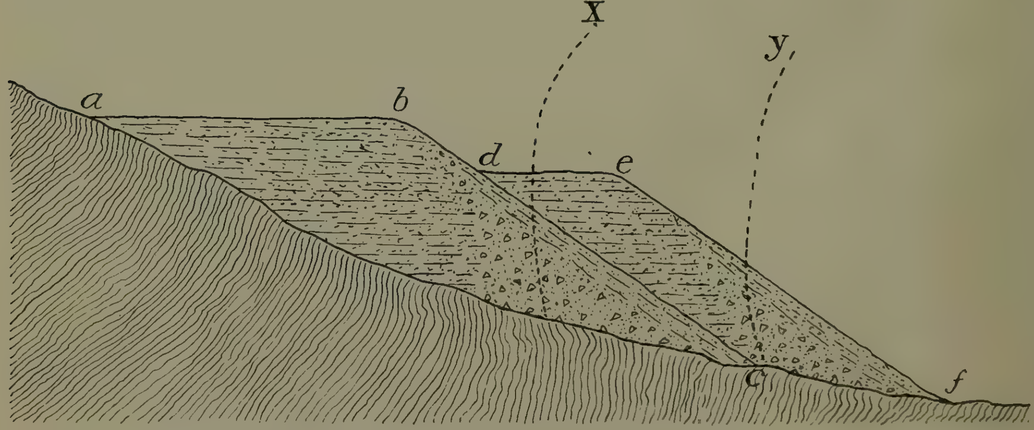
FIG. 12.

To face p. 79.



IDEAL SECTION ILLUSTRATING THE FORMATION OF A MORAINE TERRACE AT THE SIDE OF A GLACIER.

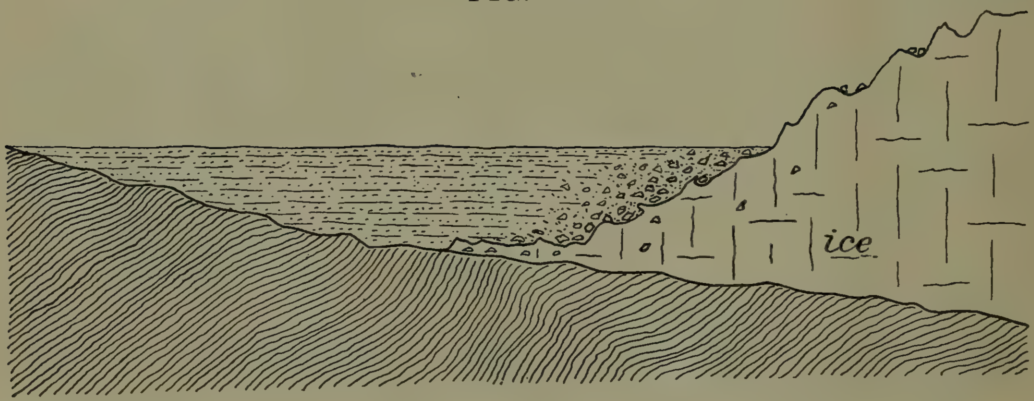
FIG. 13.



IDEAL SECTION SHOWING THE INTERVAL STRUCTURE OF GROUPED LATERAL MORAINE TERRACES.

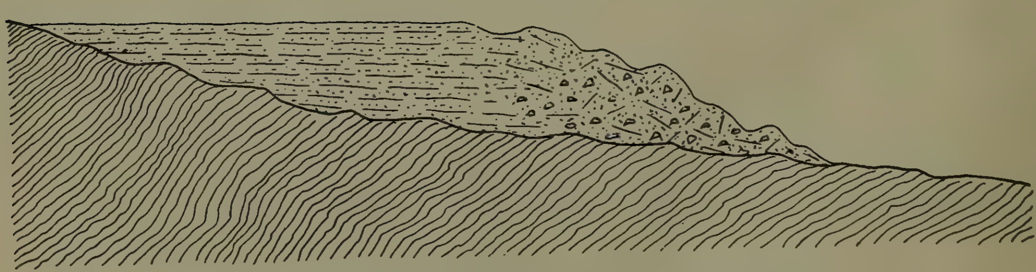
FIG. 14.

To face p. 79.



IDEAL SECTION OF ALLUVIAL FILLING AGAINST FRONT EDGE OF GLACIER.

FIG. 15.



SECTION OF RESULTING FRONTAL MORAINE TERRACE.

or structure. The glacial-derived material always forms the frontal and frontal-basal portions of the terrace. If no erosion of the terrace takes place it can usually be recognized from its composite character. Gilbert[a] further states that this form so closely simulates the stream terrace as to be in many cases indistinguishable.

As in the case of moraines two types of moraine terraces, frontal and lateral, are recognized. (Figures 12 and 13)—(Figures 14 and 15). Gilbert says:[a] "The lateral type is identical in cross profile and in longitudinal profile, and, unless portions of the morainic ridge remain, has but one formal difference; the contour of its outer face being determined by the side of an ice stream are smooth curves of gentle flexure."

Clearly, all of the terraces dotting the east and west sides of the Finger-lake valleys are lateral terraces, and in no way do they resemble stream terraces; but, as has been shown, represent true deltas deposited by streams, with their mouths at that elevation and their entrance into a static body of water. If these represented moraine terraces we should expect to find in some of them at least evidence of glacial or morainal material; on the contrary, not a single terrace examined has offered much doubt as to the kind of material of which it is composed. The absence of such material can not be accredited to erosion, as the majority of these terraces are almost as fresh as the day they were constructed. Apparently, therefore, they have suffered no erosion save that of the streams which built them, which has been in the nature of a bisection when the waters fell to a lower level and the construction of the next lower delta began. As has been shown, the morainal terrace is characterized either by a smooth flowing frontal outline or by an irregular morainal or hummocky frontal outline. The majority of the terraces so far examined in the valleys have distinctly serrated fronts, and with no structural resemblance whatever to the morainal type.

After the deposition of the terrace material against the front or lateral edge of the ice, and the withdrawal of the ice, the material which has been held up at its front by the supporting ice tongue, must

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[a] Gilbert, G K., Lake Bonneville. Monograph 1, U. S. G S., p. 83.

assume the angle of rest or repose, generally causing a considerable settling for this part of the terrace. I have been unable to detect any such necessary movement.

To sum up the characteristics of a moraine terrace, we find them to be: (1), in some cases a composite form, that is, constructed from both land and glacial derived material. (2), The terrace front is either a smooth flowing frontal outline, or, most generally, a hummocky morainal outline. From either condition would follow the absence of a serrated margin. (3), A settling or shoving motion as manifested in the frontal portion of the terrace after the retreat of the ice. (4), Closely simulating the stream terrace as regards surface slope on the terrace top and not having the true flat topped outline so characteristic of delta terraces. These characteristics, from the writer's observations, do not enter into the make up of the Finger-lake terraces. Thus, it is evident that this hypothesis is entirely at variance with the facts, and can, therefore, be eliminated and precluded from the possibilities, as being entirely inadequate to explain the terraces.

Marginal lake hypothesis

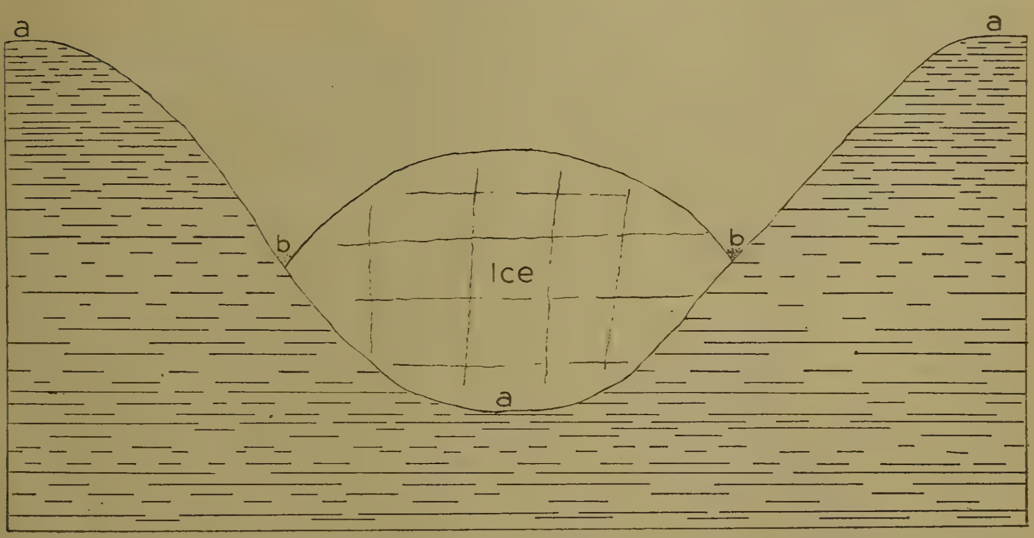
The second hypothesis postulates the existence of marginal lakes into which the streams poured and in this manner built up the existing delta terraces. The occurrence of marginal lakes along the ice border is by no means an exceptional and rare feature but, on the other hand, is in many instances found to be one of the marginal associates. There are many ways by which this kind of lake may be formed, dependent largely if not entirely upon the topographic relations of the land to the ice. No matter in what ways these lakes are called into existence, they seldom assume very large dimensions, comparatively speaking, but are usually of medium or small dimensions, grading from a mere pond up to a moderate sized lake.

In a narrow longitudinal valley similar to the ones studied here, and down which ice tongues were protruded, marginal lakes of two kinds are capable of being formed.

(a), Separate and independent lakes formed along the lateral contact between the land and ice, where tributary streams entered and thereby augmented the wastage in the ice. Or,

(b), General marginal lakes formed along the marginal contact of the stagnant ice lobe and the land, where the wastage would naturally take place and be further facilitated. Two such zones would be established, one on each side, with the ice-mass occupying the middle of the valley, separating the two water ways, which have no apparent connection with each other, except for a slight areal contact at the frontal edge, where wastage always takes place. If their contact is formed and an outlet is found at the divide, it will serve as a common overflow to both water-bodies. Otherwise, there must exist two separate and distinct overflow channels, if the lakes are drained.

Fig. 16



Diagrammatic cross-section of a valley (a a a), partially filled with a stagnant ice tongue or lobe, marked ice. Lateral drainage along ice and land contact, showing deposit at (b b). The deposits, may or may not have the same correlative heights.

Assuming this to represent the true condition, it is evident that the glacial drainage would be confined to channel ways, existing between the land and ice, where the in-pouring streams would transport their load, and under favorable conditions would necessarily deposit most, if not all of it, along the drainage ways, which at best would be irregular and confined exclusively to the valley sides. The thicker the ice mass, the higher up the valley sides would the drainage be established. This condition might endure until the ice had completely liquefied. The absence of such deposits along the valley sides accumulated by and in water bodies

as described above, which closely simulate streams, would necessarily disprove the theory. In no part of the valleys have deposits been found which could be accounted for in this way.

Another and still more probable condition may be found, which is, that the channel ways which so closely simulate streams as above described, by the absence of direct and swift drainage become true lakes, and the streams entering have their velocities checked and their load deposited and developed as a normal delta. In such an event, the delta terraces for the two valley sides and even for the same side are built in separate bodies of water, and might therefore, show no correlation whatsoever with each other; also, the lake clay and silt should show very irregular distribution, being heavier in some places along each side of the valley and entirely absent from the middle of the valley.

In his studies of the Malaspina glacier, Russell has shown the marginal lake condition to be a very common feature along the ice border. Concerning these lakes when comparing them with others of a somewhat different origin, he says:[a] "The conditions which lead to the formation of marginal lakes are unstable, and the records which the lakes leave in the form of terraces, deltas, etc., are consequently irregular. When streams flow into one of these lakes, deltas and horizontally stratified lake-beds are formed as in ordinary water bodies; but, as the lakes are subject to many fluctuations, the elevations at which the records are made are continually changing, and in instances like those about the Malaspina glacier, where the retaining ice body is constantly diminishing, may occupy a wide vertical interval."

During the summer of 1896, the writer had occasion to examine a few marginal lakes along the ice border at the base of the Upper Nugsuak peninsula in north Greenland, and the conditions existing there only add confirmation to those under which the marginal lakes of the Malaspina glacier are formed, as stated by Professor Russell. In view of these facts, correlation of the deltas occurring along the valley sides of the Finger-lakes would be impossible, if formed in marginal lakes.

Applying the test in the way of facts as they really exist in these valleys, we find upon examining the table of terraces, a fairly accurate

a Russell, I. C., Glaciers of North America. New York. 1897, p. 119.

FIG. 17.

To face p. 83.

C. S. Downes, photo.

MORAINAL FILLING IN THE CAYUGA INLET VALLEY IN THE WEST DANBY REGION.

correlation throughout; also, each correlative set has its corresponding outlet with which it can be correlated, and the terraces are not in any degree irregular deposits but true and fairly typical deltas.

It is very evident that the facts are not in any degree consistent with the marginal lake hypothesis, as it fails in its explanation thereof, and is eliminated on the same ground as the first, namely, in being inadequate as a solution.

General lake hypothesis

The third and last hypothesis is that of a general lake condition caused by a damming of the north flowing streams by the receding ice front serving as a barrier to the north. The topographic condition of the glacier front, if such a term can be applied, would have no special effect upon the results; whether the retreating front was a perpendicular or nearly precipitous wall, or, whether it was of a more or less gentle slope, the result would be the same, so long as the ice was of sufficient height and continuous across the valley.

The discussion of the terraces in the hypotheses here outlined, is restricted to the higher ones, as the lower terraces have not been thoroughly studied, and the conditions may or may not hold true with equal certainty.

Evidence of ice withdrawal as manifested in the moraines

Chamberlin[a] has traced and described the moraine filling the southern extremities of the Finger-lake valleys which he has correlated with the "Terminal moraine of the second glacial epoch." (Figure 17) The general outline of this deposit is convex southward, with its maximum convexity immediately south of the heads of Lakes Cayuga and Seneca. It is vastly stronger in development than any of the more northerly ones. The eastern part of this moraine is distinctly traceable in a northeasterly direction crossing the valley of Six Mile creek near its entrance into the Inlet valley where the filling is markedly heavy; thence, by the East Ithaca depot, into the valley of Fall creek, which it follows to and beyond Freeville, and is almost continuously traceable as far as Cortland, some 20 miles northeast from Ithaca. Its western part is somewhat

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a Third ann'l report, U. S. G. S., 1881-'82, 353-360.

strongly marked near Cayutaville in the Cayuta lake valley, and again in the Seneca valley to the south of Watkins.

Apparently, a second halt is represented in a very meagerly developed moraine just south of the town of Ovid, some 20 miles north of Ithaca. The Ovid moraine may have its correlative to the east, in the Owasco valley between Groton and Locke, where it has attained a somewhat moderate but conspicuous degree of development. On the west it seems to have its correlative part in the Gorham kame area found to the south of the town of Gorham in the Flint creek valley.

There seem to be some evidences of a third halt in the ice immediately north of the present lakes, in the form of distinct morainal deposits.

The most significant fact indicated by the lack of development of these morainal masses is, since they almost certainly indicate or prove briefness in ice halt, that they suggest as strongly, briefness in the various lake stages held up by the retreating ice front.

Evidence supporting the general lake hypothesis

The facts supporting this hypothesis and which serve as criteria are here classified under the following headings:

1 Possible berg deposits.

2 Lake clays and silts. The necessary result of lacustrine deposition.

3 Unlike conditions in the materials found above and below the line of highest water level. This, however, is not always well marked and the differentiation in most cases is difficult if not quite impossible.

4 Strongly defined overflow channels, through which the glacial lake waters drained. The channels are distinctly shown and are easily traceable, thus affording rather strong evidence in favor of the once existent glacial lakes.

5 Shorelines. These are for the most part constructional features in the form of delta terraces. Some probable destructional forms in the way of till cuttings as benches formed in part by wave action and occupying the interstream areas, where the drift is heaviest, are apparently shown. The most significant and reliable of these are the delta terraces. They show not only a very close

TABLE No. 1

Showing the height of the terraces in each of the lake valleys with the several stage correlations.[a]

CAYUGA LAKE

West Side Streams: West Danby	Van Buskirk	West Branch	Butternut	Woodcock	Coy Glen	Williams creek	Glenwood	Willow creek	Taughannock	Trumansburg	Sheldrake	East Side Streams: South Danby	Stream 1 mile north of South Danby	Stream opposite Van Buskirk	Lick brook	Buttermilk	Six Mile creek	Cascadilla	Fall creek	Salmon creek	Stages and overflows
1049	1066	*	*	*	*	*	*	*	*	*	*	*	1071	*	*	*	*	*	*	*	West Danby levels Overflow=1039
* *	1034	*	*	*	*	*	*	*	*	1047	*	1031	1031	1031	*	*	1020(*H*)	*	*	*	Ithaca levels
	*	985	*	*	1006(*L*)	*	*	*	*	*	*	*	*	*	985	975	*	*	*	*	Overflow=975
954				950	955(*L*)										950			948			
914	934	920	915		*	*	*	*	919(*L*)	919(*L*)	*	906	*	*	915	920	*		*	*	
*	836	*	*	890	864(*L*)	*	*	*	843(*L*)	868	*	*	*	*	*	892	*	*	*	*	
*	826		845	*	828(*L*)	*	*	*	834	827		*	*	*	*	834	*	*	*	*	
*	816	825	800	*	804(*L*)	*	*	*	804	807		*	*	*	*	800	*	*	808	*	
*	*	*	785	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	
*	*	740	745	*	*	768	*	*	766(*L*)	*		*	*	*	*	*	*	*	*	*	
*	*	*	710	*	726	*	*	*	*	*		*	*	*	*	*	*	*	718	*	
*	*	*	*	*	*	*	*	628	674	*		*	*	*	*	*	*	628	658	628	
*	*	*	*	*	589	*	563		564	558											
					507	*	518	528		518		*	*	*	*	*	523	*	573	578	
*	*	*	*	*			468	*	*	468	488	*	*	*	*	*	*	*	*	508	
*	*	*	*	*	*	*		*	*	403		*	*	*	*	*	*	*	*	488	

SENECA LAKE

Watkins Glen	Big Stream (Dundee)	Bimrods	Havana Glen	Cramer Gulf	Burdett	Lodi	Weed creek	Stages and overflows
*	*	*	*	*	1021(*L*)	1015	*	Watkins levels
969(*L*)	990							Overflow=900
925(*L*)	940	947	*	*	*	940	*	
900(*L*)	*	922	906(*L*)	957	927(*L*)	915	919	
*	*	*	*	*	898(*L*)	*	*	
*	880	*	*	*	846(*L*)	840	839	
803(*L*)	830	842	832(*L*)	*	818(*L*)	808	800	
790(*F*)	*	*	783(*L*)	777	794(*L*)	*	*	
	*	*	771(*L*)	*	786(*L*)	*	*	
760(*F*)	*	*	721(*L*)	732	772(*L*)	751(?)	727	
*	*	*	652(*L*)	*	709(*L*)	*	677	
*	*	*	*	*	*	591	577	
						551		
						491		

KEUKA LAKE

Laughlins Glen	Glen brook	Urbana	Stages and overflows
1158			
	1123	*	Hammondsport levels Overflow=1125
*	1018	*	
911(*F*)	938	928	
*	*	840(?)	

CANANDAIGUA LAKE

Tannery Glen	Parish Gully	West Hollow brook	Stages and overflows
*	*	1160	
*	*	1127(*F*)	
*	*	1114(*F*)	Naples levels
*	*	1088(*F*)	
1015	*	1011(*F*)	
960	965	960	
		920	
*	845	*	

OWASCO LAKE

Ensenore	Casowasco	Stages and overflows
1022	1022	Groton levels Overflow=970±
		Newberry levels
902	902	Overflow=900.
*	832	Warren levels
*	822	

[a] (*L*) = measured with a surveyor's level by O. L. W. (*F*) = measured by Professor H. L. Fairchild. (*H*) = measured with a hand level by T. L. W.

correlation with each other but with the overflow channels as well. While the remaining criteria are, as a rule, rather plainly and somewhat strongly marked, they can not be considered in any degree as primary factors, but only as efficient and emphatic aids to the prominent or primary ones.

With such preliminary description as has already been given of the above criteria they can best be considered under each lake stage, where they will be discussed.

Terminology

In naming the various lake stages the writer has adopted the names first proposed by Fairchild.[a] Each level having a separate and independent outlet has been named for the most prominent town within the old lake area. Thus, each one of the local stages has received a geographic name, while the first coalescing of all the local waters into one large body, has been given a non-geographic name and called in honor of one of our ablest geologists, the late Professor Newberry. This stage in the lacustrine history of the Finger-lakes has been named glacial lake Newberry.

West Danby lake stage

Markings of lake level:

Delta on stream one mile north of South Danby creek, 1071 feet.

West Danby creek, 1049 feet.

Van Buskirk creek, 1066 feet.

Extensive gravel deposits are found at about the 1066 foot elevation for the entire distance from Van Buskirk creek to West Danby, some five miles southward.

Evidence and history of lake. The West Danby level is marked by gravel deposits on most of the streams at and between the elevations of 1050 and 1070 feet. Extensive deposits are found on Butternut creek, and the level is well marked on Van Buskirk creek at an elevation of 1066 feet above tide. From West Danby to Van Buskirk creek a prevailing gravelly condition is distinctly traceable for the entire distance, some five miles, and where small

a Bull. geol. soc. Am., 1895, 6, 353-374.

streams have entered at this elevation, their mouths are marked by prevailingly coarse gravel. On the east side of the valley beginning at South Danby creek and travelling northward for about one mile, when the next stream debouching into the valley is reached, and, at about the 1070 foot elevation, are found distinct cuts or benches in the till, covered in some cases at their bases with water worn material, which are probably modifications in part resulting from wave action.

The outlet to the West Danby lake was at Spencer Summit with an elevation of 1039 feet. (Figure 2) When the ice commenced its northward retreat uncovering the divide region in the southern parts of the valleys of the Finger-lake region, the waters were ponded back between the divides and the ice front and held up to the heights of the divides in their respective valleys. This condition marked the beginning of the epoch of local lakes in several of the lake valleys. There existed such a lake in each of the Finger-lake valleys. Of these, three, probably, had their birth about the same time and were probably the first to make their records of a long and successive series of lakes whose markings are still seen to be so distinct and traceable in most of the valleys of the central New York lake region.

The West Danby stage is not represented by sharp and well defined terraces but mainly by a distinctly traceable overflow, unlike surface conditions above and below the outlet level, which in most cases are very faintly developed and are very irregular. Several indistinct delta terraces are found along a few of the streams which entered at the lake level. The best one yet seen, is found on a stream which enters the Inlet valley one mile north of South Danby creek at an elevation of 1071 feet. On all of the streams of any size are found more or less extensive gravel deposits, but not in the form of true deltas.

The Danby stage marks mainly an epoch of frontal ice accumulations, when the moraine which fills the Inlet valley to a very great but unknown depth, was in process of construction, and which extends from the divide to within a few miles south of Ithaca. When the ice had withdrawn as far north as Ithaca from the Inlet and Six Mile creek valleys, the waters held up in these two valleys coalesced. The Danby stage was quickly closed by a rapid and

sudden falling of its waters to the level of the White Church overflow, previously occupied by the local lake Brookton, which marks the beginning of a new episode in the ice dammed waters, namely, the beginning of glacial lake Ithaca. The records left by the West Danby, as well as the Brookton stage, point apparently to a very brief lake existence.

Brookton lake stage

Markings of lake level:

Six Mile creek. Brookton delta, 1020 feet

Slight and scattering gravel deposits are found at about the same elevation to the northwest of Besemer depot on both sides of the valley.

Evidence and history of lake:

The outlet to the Brookton stage was by White Church with an elevation of 975 feet.

This was the beginning of the Ithaca stage, which was formed by the coalescing of the waters of the Danby lake with those in the Six Mile creek valley, after the ice had retreated to the region round about Ithaca. It was a local lake occupying the Six Mile creek valley with its overflow by White church, and was analogous to and contemporaneous with the local Danby lake then occupying the southern part of the Cayuga Inlet valley. It was a lake separate from the Ithaca waters, and was in existence for a length of time sufficient for the ice to withdraw from the divide at White church, past Brookton to Ithaca. The evidence which marks the life of such a local body of water is essentially the same as that bearing testimony to the existence of the Danby lake.

Excluding markings left to record such local lakes, which might very well be erased after so very brief a history, due entirely to rapid retreat in the ice, we could be assured of the existence of these lakes upon comparative theoretical grounds. No streams are found tributary to Six Mile creek, of sufficient size to be dignified by the name creek, hence, it would be impossible to find records here in the form of deltas. However, abundant evidence exists in the way of gravels found on the streamlets debouching into Six Mile creek at an elevation of from 985 to 1030 feet. Two such

deposits are very well shown, one on the east side of the valley one mile north of Besemer depot, and a second about the same distance from the station on the west side. Numerous smaller deposits of similar character are found along the valley sides of Six Mile creek, and also notches of an irregular form but of a correlative height cut in the drift and possibly representing to some extent the result of wave modification.

When the Danby waters were added to the White Church lake and glacial lake Ithaca was initiated, practically no fall in the White Church waters occurred, but the same level and overflow was maintained throughout the Ithaca stage. Hence the Brookton delta was partly built during the White Church epoch and completed during that of lake Ithaca. This delta, which is one of the largest and most extensive in any of the delta series, is therefore a record of the White Church as well as the Ithaca lake episode. The records begun by the waters of the former were completed by those of the latter.

Watkins lake stage

Markings of lake level:

Burdett, 1021 feet.
Lodi, 1015 feet.
Big stream, 990 feet
Watkins, 969 feet.
North Hector, 970 feet.

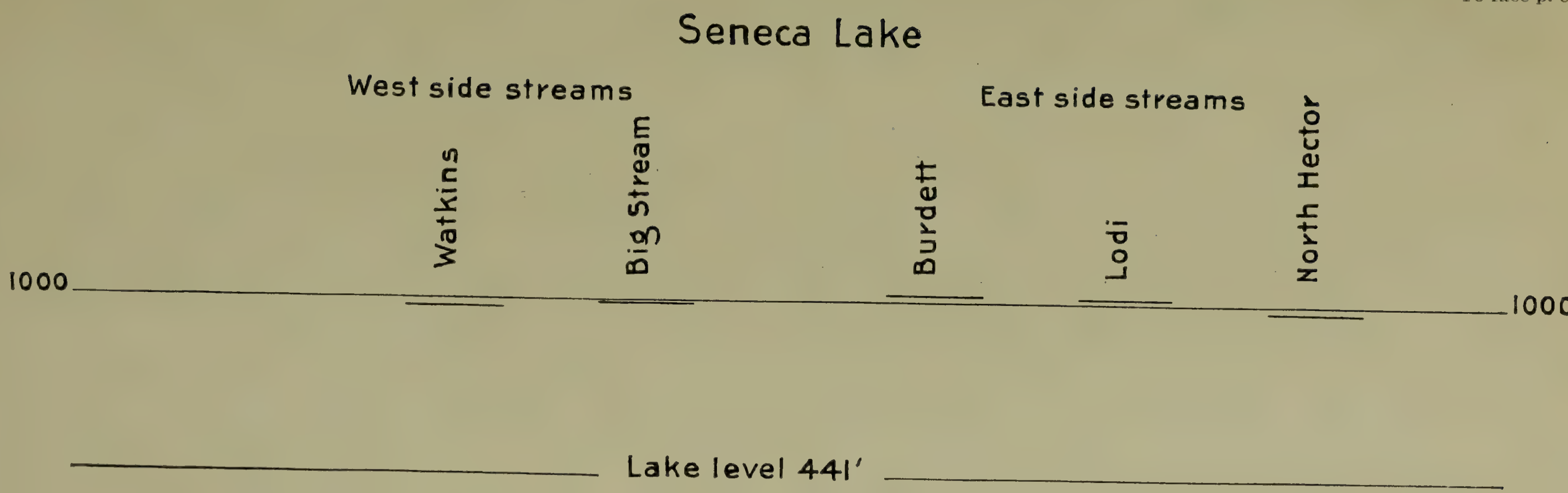
Havana. Not a definite terrace but a distinct till plain covered with considerable water-worn gravel. 968 feet.

Weed creek. Not a distinct delta in outline but an irregular deposit of sand and gravel.

Evidence and history of lake. The outlet to glacial lake Watkins was near the village of Horseheads with an elevation of 900 feet. This stage was initiated by the uncovering of the Horseheads divide by the ice, and continued until the waning ice sheet had retreated north of the town of Ovid, when the waters were united with those of glacial lake Ithaca to inaugurate the initial stage of glacial lake Newberry. Abundant evidence confirms the existence of this lake, in the form of true deltas; unlike conditions above and below the water

To face p. 88.

FIG. 18.



The Terrace levels of Glacial Lake Watkins.

line; broad, undulating plains of till with water deposits covering portions of their surfaces, probably thus modified by the waters of the Watkins level, found opposite the mouths of the streams entering from the two sides of the valley. Lastly, evidence is found in a very strongly defined outlet channel to the south leading into the Chemung river. The most conspicuous deltas marking this level are found at Burdett and Lodi on the east side of the Inlet valley, and at Watkins on the west side. Other markings of a much less definite character were noted at Dundee and on Weed creek on the west side, and on North Hector and Havana Glen streams on the east side of the valley.

Other things being equal, glacial lake Watkins must have had a longer time existence than any one of the other local lakes, since it was necessary that a northward recession of the ice amounting to some 35 miles should take place before the next lower level was established.

The outlet to the two stages, glacial lakes Watkins and Newberry, remained the same and endured through and to the close of the Newberry episode, when it was shifted to the north and west of Canandaigua.

Hammondsport lake stage

Markings of lake level:

Laughlins glen, 1158 feet.
Glen brook, 1123 feet, 1018 feet.

Evidence and history of lake. The outlet to glacial lake Hammondsport was over the col between the towns of Hammondsport and Bath with an elevation of 1125 feet. The Hammondsport stage, or the highest ancestral water level of the present Keuka lake which is 718 feet above tide, is marked by two large and conspicuous deltas just above the town of Hammondsport on opposite sides of the valley. The one on the east side at Laughlin's glen has an elevation of 1158 feet above tide, the other, is on Glen brook which enters the Inlet valley from the west and has an elevation of 1123 feet. A terrace on the same stream is found at the 1018 foot elevation and marks an intermediate halt between the Hammondsport and Newberry levels.

The moraine in the divide region of the Keuka valley is well developed, and in the neighborhood of Bath merges into and is replaced by the gravel flood-plains skirting the overflow channel.

As soon as the receding ice sheet had uncovered the lower lands in the region of Penn Yan, or the northern part of the present lake, the water fell to the level of glacial lake Newberry, some 200 feet below the local lake levels It will be observed, however, in the subsiding of the waters from the Hammondsport to the Newberry level, that it was not entirely sudden, but represented by a rather prolonged and intermediate halt at an elevation of about 1018 to 1020 feet. The same intermediate level, in the form of a terrace, while not given for Laughlin's glen is as well defined as the one measured on Glen brook.

Flint creek stage

Flint creek heads in the Canandaigua territory not far from the town of Naples, between lakes Seneca and Canandaigua, and flows in an almost direct northerly course to join the Canandaigua outlet stream a little west of north from Geneva. It occupies a very extensive valley, which was at one time the scene of a lake similar to the ones found in the southern portions of the present lake valleys, although no definite terraces[a] were found in any part of the valley. When the ice had retreated as far northward as the villages of Gorham and Stanley the waters in the Flint creek valley found a low pass to the eastward and fell to the Newberry level, which level in the Flint creek valley was sustained throughout the existence of lake Newberry. Its waters were added to Newberry just before or about the time that the waters of glacial lake Naples were united, as Flint creek finds an outlet at present through the lowest part of the divide between the upper portion of Lakes Seneca and Canandaigua at Stanley. Unlike the other valley members of the Finger-lake system, no lake occupies any part of the Flint creek valley at present.

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a Since this paper was admitted to press, Professor H. L. Fairchild has published an article entitled "Kettles in glacial lake deltas," Journ. geol., 1898, 6, 589-596, in which he gives the elevations of two terraces found near the village of Pot er on the West side of Flint creek valley as follows: 1150 feet, 1080 feet. The highest one of these, Fairchild says, "corresponds with the summit levels of the several old deltas in the Keuka valley proper," while no positive correlation has been worked out from the 1080 foot level.

FIG. 19. To face p. 91.

NAPLES LAKE. OUTLET CHANNEL. VIEW LOOKING NORTH, OR UPSTREAM, FROM NEAR THE MOUTH OF CHANNEL. (After H. L. Fairchild.)

Naples lake stage

Markings of lake level:

West Hollow brook. 1160 feet. 1127 feet. (Fairchild) 1114 feet. (Fairchild) 1088 feet. (Fairchild) 1011 feet. (Fairchild)

Tannery glen. 1015 feet. The highest terraces on this stream were not measured.

Evidence and history of lake.

The outlet to the Naples lake was over the col into the Cohocton creek valley. (Figure 19) The elevation has not been taken. The terraces marking this stage are large and well developed, though some of the highest have suffered slight erosion, causing a somewhat irregular surface. The waters fell very gradually from the Naples level to that of lake Newberry, which condition is well shown in a series of some four or more quite strongly defined terraces, occurring at elevations intermediate between the Naples and Newberry stages. The time interval from the beginning of the maximum or Naples stage to that of the Newberry, is represented in the northward retreat of the ice from the southwest of Naples to the lowlands near the northern end of the present Canandaigua lake.

Groton lake stage

Markings of lake level:

Ensenore creek. 1022 feet.
Casowasco creek. 1022 feet.

Evidence and history of lake. The final outlet to glacial lake Groton was over the col, in the region of North Lansing with an elevation of 970+ feet. The southern end of the Owasco valley is clogged with moraine, which begins at Locke and extends southward to and beyond Groton, thus giving a width of some four miles. The moraine is fairly well developed in some places and rather scanty in others. It is partly stratified in places, but for the most part it is made up of the unassorted material so characteristic of true moraines. The divide, however, is located some eight miles south of the moraine at Dryden summit with an elevation of 1220.9 feet above tide. The valley is a broad one, and the walls or sides are

less steep than in the divides of the other valleys belonging to the Finger-lake system. A small local lake was held up to the elevation of the Summit col and its waters passed southward by Owego into the Susquehanna. When the ice had receded as far north as Freeville, a lower pass was uncovered and its waters conducted through the Fall creek valley into glacial lake Ithaca just north of the city of Ithaca. The outlet by way of Fall creek at Freeville, has an elevation of 1046+ feet, and was held for only a short time; sufficiently long, however, for the receding ice to uncover the region round about Locke and North Lansing, when the drainage was again shifted to the north but more permanently fixed.

Professor G. K. Gilbert informs the writer that he has found a distinct and well defined scour-way [a] in the neighborhood of North Lansing leading into a stream tributary to Salmon creek, which enters Cayuga lake a little to the south and west of the town of Ludlowville, through which the waters of glacial lake Groton must have found escape.

Professor Gilbert further states that, while the evidence for the existence of this cannot be mistaken, its dimensions would rather indicate an escape of a not very large volume of water, and that it was probably not occupied for any very considerable length of time, although much more strongly defined than the Freeville outlet. Its elevation as given by Gilbert is between 960 and 980 feet, nearer the former, however. (Figure 20)

The North Lansing overflow is the most northerly one through which the waters of the Groton stage found independent drainage into lake Ithaca. It was held until the ice had retreated sufficiently far northward to uncover the lowerlands to the west, when the Groton stage was closed by a falling of its waters to the Newberry level.

Thus the lake at Dryden summit found independent drainage to the south, while the expanded waters afterwards discharged at different times through two outlets, more northerly located the one at Freeville, and the other at North Lansing, into glacial lake Ithaca.

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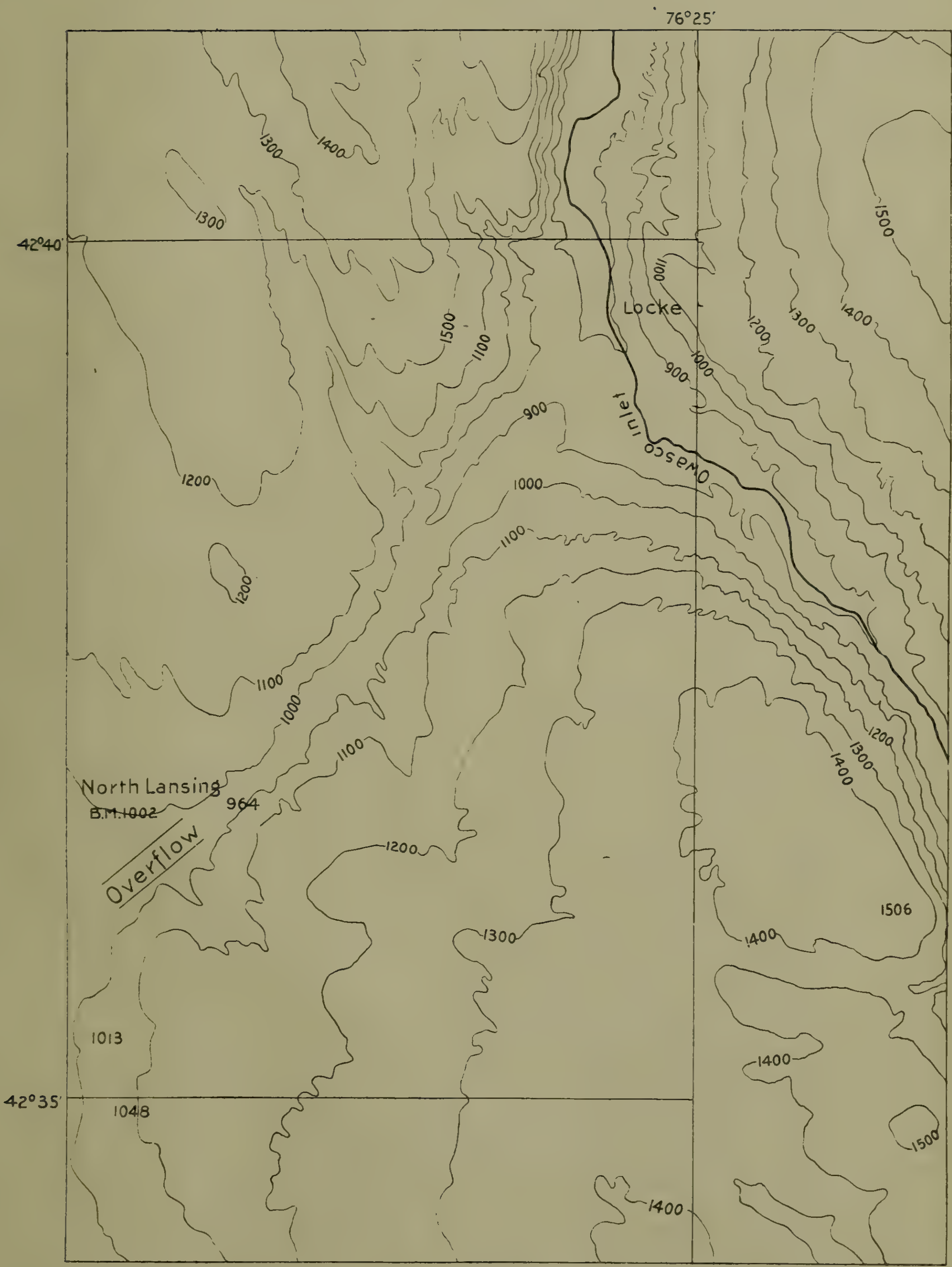
a I am indebted to Prof. Gilbert for a knowledge of the existence and description of the North Lansing overflow.

FIG. 20.

To face p. 92.



THE NORTH LANSING OVERFLOW. THE MOST NORTHERLY OUTLET TO GLACIAL LAKE GROTON LEADING INTO GLACIAL LAKE ITHACA. (BASED ON THE UNFINISHED MORAVIA TOPOGRAPHIC SHEET, U. S. G. S., CONTOURS 100 FEET.)

Well developed deltas were studied and measured along the stream course, which is tributary to the Owasco valley from the east side, at Moravia. Two distinct water levels are represented; the highest one has an elevation of 1005 feet, and the lower one, which is expressed in two terraces with elevations of 880 and 850 feet. The 880 and 850 elevations clearly represent the level of the Warren waters in the Owasco valley. The same level is apparently represented at Locke, with an elevation of 865 feet.

The delta deposits on Casowasco and Ensenore creeks consist of beautifully stratified sands and gravel with a sandy loam for the soil covering. They are not true deltas, but that they represent a lake level at that elevation does not admit of very much doubt. Both Ensenore and Casowasco creeks enter Owasco lake from the west side, the former entering about three miles north of the head of the lake, and the latter about one mile to the south of Ensenore. They are small streams but are the largest debouching into the lake. Forms closely resembling deltas were seen at about the same level on several streams entering the lake near its head and from the east side of the valley. When occupying this maximum level, the lake was some 21 miles longer than at present, and had an additional depth of some 237 feet.

The terrace markings of both the Groton and Newberry levels are at best but faint, when compared with the similar markings of the other lakes. A reasonable explanation for the indistinctness of these shore markings would seem to be found in the smallness of the streams entering at that time, and also, the briefness of the lake's existence at these two stages. Furthermore, after the ice had uncovered Ensenore creek it had only a distance of some 10 miles or less of northward recession, before its waters would fall to the Newberry level and coalesce with those of the Ithaca lake on the west, inasmuch as the divide between Cayuga and Owasco lakes lowers very rapidly to the north after passing Ensenore creek. Therefore, the delta accumulations representing the Groton level must be proportional to the time which the ice would require in retreating to a point less than 10 miles north, when the Newberry level would become established in the Owasco basin, which from an absence of morainal deposits and other conditions as well, indicate a rather rapid recession.

It is a noteworthy fact that the terraces found below the Newberry level reached a much better stage of development, and are in most

cases fairly strong and well marked. They were noted at the following elevations, 880, 865, 850, 832, 822 and 792 feet, down to those forming in the present lake, which are of good size, covering as much as three to four acres in some cases. The slight development of the delta deposits along the above mentioned streams, and correlated with the North Lansing overflow are in every way harmonious with the brief occupancy of that channel way. The characteristics of the deposits, which are slight and rather imperfect in development, and very limited in areal extent, though built of stratified sand and gravel, would suggest but a short period of time for the occupancy of the waters at that level.

Ithaca lake stage

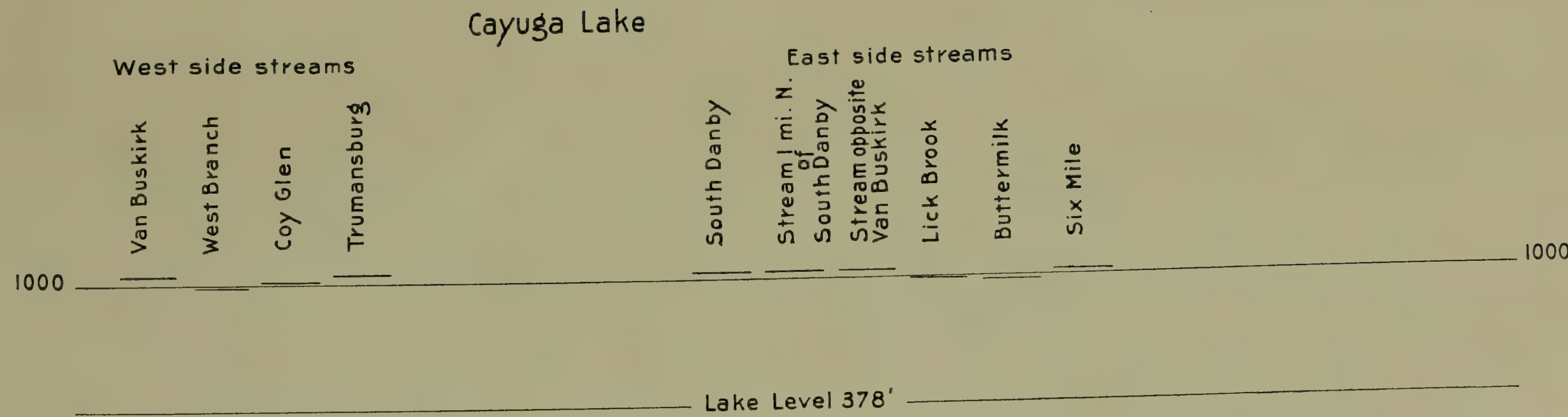
Markings of lake level:

Brookton. 1020 feet.
Besemer. 1010 feet.
Cemetery on Six Mile creek two miles west of Brookton. 975 feet.
Water worn material on stream crossing D. L. & W. R. R., south side of Six Mile creek and one mile west of Besemer, 975 feet.
Stream on the north side of Six Mile creek one mile west from Besemer. 1000 feet. 1025 feet.
Coy glen. 1006 feet.
Van Buskirk creek. 1034 feet.
South Danby creek. 1031 feet.
Stream one mile north of South Danby creek. 1031 feet.
Stream opposite Van Buskirk creek. 1031 feet.
Lick brook. 985 feet.
West branch (Newfield). 985 feet.
Buttermilk. 975 feet.
Trumansburg. 1047 feet.

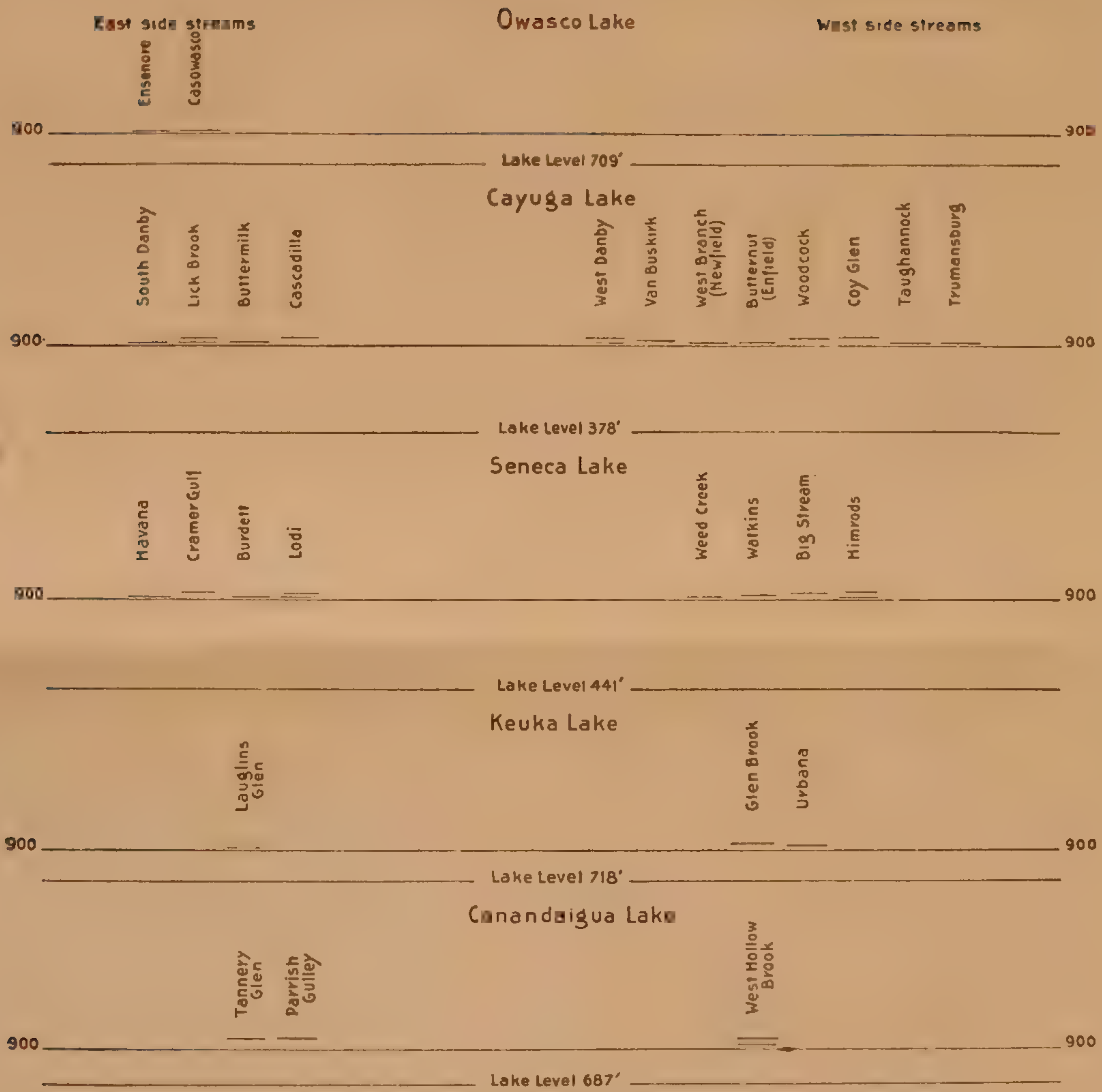
Evidence and history of lake. The outlet to glacial lake Ithaca was over the col at White Church with an elevation of 975 feet. The Ithaca level is defined by a large number of strong and definitely developed terraces, varying in elevation from 975 to 1047 feet. The largest of these are the Brookton delta, formed by the north branch of Six Mile creek at the town of Brookton, those on Lick brook and Buttermilk on the east side of the Inlet valley, and on West branch and Coy glen on the west side. The same level is recorded on

To face p. 94.

FIG. 21.



The Terrace levels of Glacial Lake Ithaca



The Terrace levels of Glacial Lake Newberry

numerous other streams entering from each side of the valley, which have not reached so marked a degree in development. These can be seen by referring to the table of terraces opposite page r84. The farthest north that this stage is delineated is just above the town of Trumansburg, some 11 miles north of Ithaca on the west side of Lake Cayuga, where the marking is in the form of a very imperfectly defined delta. The line is marked by a small burying ground some 40 to 50 rods away from and on the south side of the creek. The ice receded some 14 miles north of this point before the Ithaca stage was closed and the next lower inaugurated.

On the east side of the valley the most northerly trace of the Ithaca level is found on Buttermilk creek about two miles south of Ithaca, where a very extensive delta has been built with its front over-looking the Ithaca wagon road near the stream crossing. This may be due to the failure to recognize these shore lines among the complex moraine of Fall creek valley.

When the ice had withdrawn from the Inlet and Six Mile creek valleys, sufficiently for the West Danby waters to fall to the White church level, the West Danby and White Church glacial lakes coalesced to mark the beginning of a lower and more extended body, that of glacial lake Ithaca. This level in the static waters was held until the ice had wasted back sufficiently to uncover the low divide between lakes Cayuga and Seneca in the neighborhood of the town of Ovid, with the overflow established at White Church, when the waters fell to the next lower stage, and the outlet shifted from the Six Mile creek valley to the col at Horseheads in the Watkins valley.

The Ithaca glacial lake represents a period of time much longer than that recorded by any one of the previous stages, revealed in the number of unusually strong and sharp terraces. The Brookton delta already referred to as being one of the most extensive shore deposits found in the lake region, was built mostly during the Ithaca stage, although its beginning dates back to the life of the local glacial lake Brookton.

Newberry lake stage

Markings of lake level:

Owasco lake valley

Ensenore creek. 902 feet.

Casowasco creek. 902 feet.

Cayuga lake valley

Butternut creek. 915 feet.
Woodcock stream. 950 feet.
Coy glen. 955 feet.
Taughannock creek. 919 feet.
Trumansburg creek. 919 feet.
Van Buskirk creek. 934 feet.
West Branch (Newfield). 920 feet.
West Danby creek. 914 feet. 954 feet.
South Danby creek. 906 (?) feet. Doubtfully referred to a delta.
Lick brook. 915 feet. 950 feet.
Buttermilk creek. 920 feet.
Cascadilla creek. 948 feet.

Seneca lake valley

Weed creek. 919 feet.
Watkins glen. 900 feet. 925 feet.
Big stream. 940 feet.
Himrods creek. 922 feet. 947 feet.
Cramer gulf. 957 feet.
Burdett stream. 927 feet.
Lodi stream. 915 feet. 940 feet.

Keuka lake valley

Glen brook. 938 feet.
Urbana stream. 928 feet.
Laughlins glen. 911 feet. (F.)

Canandaigua lake valley

West Hollow brook. 920 feet. (909 feet. (F.)) 960 feet.
Tannery glen. 960 feet.
Parrish gully. 965 feet.

Evidence and history of lake. The outlet to glacial lake Newberry was over the col at Horseheads with an elevation of 900 feet. (Figures 8 and 9) Fairchild[a] has proposed the name *glacial lake Newberry* for the coalescing waters of lakes Seneca and Cayuga, with the inflow of waters from the east and west lakes belonging to this series, in honor of one whose name is so intimately associated with the glacialogy of this country, namely, the late Professor John Strong Newberry.

(F.) Measured by Professor H. L. Fairchild.
[a] Bull. geol. soc. am., 1895, 6, 368–369.

Lake Newberry was the most extensive and comprehensive body of water in New York state south of the Great Lakes. Its level, along the stream courses tributary to the lake valleys with elevations above sea level, is indicated in the above tabular statement of the delta terraces marked Newberry stage. (See Table opposite p. r84)

The Newberry level found on the Taughannock–Trumansburg creeks is especially noteworthy on account of its size and development. While these streams enter Lake Cayuga at present through distinct channels separated frcm each other by a distance of about two miles, careful study[a] has revealed the fact that Trumansburg creek was a tributary to Taughannock creek in preglacial times, with its point of confluence a little south but near the town of Trumansburg. The Newberry delta has obscured the place of contact or junction. During this, as well as the Ithaca stage, the two streams were dismembered and entered glacial lakes Ithaca and Newberry as separate streams. Each began a delta at the Newberry level, and these, before its close, coalesced into one immense deposit. It covers a large area and, so far as revealed by sections, exposed in many places, is almost entirely composed of fine material. The sand from this delta has an extended local reputation for building purposes in that section. Its front is fairly well defined throughout, though more conspicuously developed along the south side of Trumansburg creek where the town cemetery is situated. The delta top is quite level, but broken here and there by slight irregularities in the form of sand accumulations. It rivals any shore deposit found anywhere in the Finger-lake region.

When the Newberry waters were at their maximum they meant the blending of the waters of the higher levels in all of the local lakes, from Lake Canandaigua on the west to Lake Skaneateles on the east. This stage was immediately prior to the easternmost extension of the Warren waters across the plain to the south of a portion of Lake Ontario. The predecessors to this great expanse of water, which later fell and united to form the Newberry level, caused by a farther removal northward of the waning ice barrier, were glacial lakes Skaneateles, Groton, Ithaca, Watkins, Hammondsport, Flint creek and Naples. The manner and condition of the

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a A thesis presented to the faculty of Cornell university for the degree of B. A., by R. M. Evans, June 1897—Unpublished.

retreat of the ice as marked by its terminal moraine in the divide region, indicates that the blending or uniting of the waters marking the ancestral stages in the southern parts of the present lake valleys, did not unite all at once, but coalesced rather gradually. The beginning of the stage was marked by the coalescing of the waters of glacial lakes Ithaca and Watkins when the ice had retreated as far north as the town of Ovid, where were left markings of the waters in the form of shore deposits, such as stratified sand, gravel, etc.

Ovid deposits. On the north side of the east and west road leading to Willard's depot in the Seneca basin, and opposite the Ovid cemetery, are found several cuts revealing finely stratified coarse sand and gravel capped by some 18 to 36 inches of till. The cuts are approximately six to seven feet in depth but do not penetrate through the stratified material. No streams are to be found in the region at present, nor were any present during preglacial times, or else every trace of them has been obliterated, hence, delta deposits must be precluded as the source of origin of the materials. The deposits, however, seem to point rather strongly to the following conditions under which they were laid down. No doubt can be entertained as to the materials being the result of water action. The ice had withdrawn northward sufficiently to uncover the land and allow a falling of the waters of lake Ithaca to the level of and coalescing with those of lake Watkins. The space occupied by the lake waters, between the land on the south and the ice front on the north, was probably not very wide at this point. In this water space the stratified deposits were assorted and laid down, derived in greater part perhaps from the ice, when the latter readvanced a short distance and covered the deposits with the depth of till found capping the water laid material. In other words the ice front, at this point, was not withdrawing uniformly and progressively northward; neither was it occupied in any permanent or protracted halt, but was oscillating back and forth. The elevation of the deposits by aneroid measurement is 953 feet above sea level.

The till found capping the assorted material becomes thinner to the north and grows thicker southward, when it finally merges into the slight morainal deposits about one mile south of the town.

The progressive thickening of the till and the proportional thinning of the underlying sand and gravel are well shown in the digging of graves in the town cemetery. No crumpling, folding or disturbance of any kind could be recognized in the under deposits of sand and gravel, but seemingly, were in their normally formed condition. The thinning of the till to the north can probably be explained as a result of lake modification.

Maximum stage and water extent. The Hammondsport stage, in the Keuka lake valley, was closed about the time that Ovid was uncovered by the ice and the waters in this lake basin were added to those of lake Newberry in the basins of lakes Cayuga and Seneca. The lower lands to the north and at the outlet portion of Keuka lake basin were uncovered by the ice about the same time that the Ovid divide was exposed, and glacial lake Newberry was limited to the coalesced waters in the entire Keuka valley and only a part of the Cayuga and Seneca valleys. The ice still occupied the northern parts of the two latter valleys at this time. The limit in the Newberry waters was maintained until the ice again changed its position and the northern portions of the Cayuga and Seneca basins were uncovered, when the waters of glacial lakes Naples and Flint creek on the west, and of glacial lakes Groton and probably Skaneateles on the east, were added. The maximum level as well as the extent of glacial lake Newberry, was thus marked and held until the ice again suffered a sufficient wastage northward to expose a lower col to the north and west, when the Newberry lake abandoned its overflow to the south through the Seneca valley for that of a lower level to the northwest.

Other terrace markings in the Keuka and Canandaigua valleys. Deltas, not given in the table of terraces (see opposite p. r84) were noted at the following places in the Keuka valley, and although not measured were taken to represent the Newberry lake level: on the west side of the lake at Snows glen, some two miles north of Hammondsport; and at Drakes point, between Snows glen and Urbana. They have been seen on several streams which enter the lake to the north of and between Urbana and Pulteneys, and are rather strongly marked in the region of the latter place, about eight miles north of Hammondsport.

Generally speaking, the streams which enter the lake from the east side are smaller and other conditions for delta construction are very much less favorable, than on the west side. However, topographic configurations closely resembling deltas of very imperfect formation are seen along the east side streams all the way for a distance of some three to five miles north of Hammondsport.

Delta forms are also seen along the following streams entering Canandaigua lake from the west side, and are placed approximately at the Newberry level: Lapham's glen, two and one half miles north of Naples; the stream entering at Seneca point landing; Victoria glen, one and one half miles north of Seneca point landing; and on Menteiths creek which enters some eight miles north from the head of the lake.

Comparative strength in the development of the Newberry terraces. The shore features found marking the Newberry level when considered collectively, are the largest and therefore more strongly defined in development than any single set which mark the level of any one of the other lake stages. (Figures 23 and 24)

The stronger development of the Newberry terraces over those of any other stage would suggest one of two conditions prevailing at the time of formation. First, that this level was held for a longer period of time than any previous or subsequent one thus far studied, during which the activity of the streams, in the transportation and deposition of material while no greater than for any other period, enabled the streams to accomplish a greater amount of work. Or, second, that the time limit, being no greater than for any previous or subsequent stage, the agencies concerned in the processes of collecting (erosion), transportation and deposition of materials were more vigorous, and attained a very much greater degree of activity than for any one of the other periods.

When considered singly, neither of the two possibilities here offered entirely meets or satisfies the conditions, but the field evidence tends to combine these and suggests a greater activity in stream work combined with a longer stay in the static waters at the Newberry level, at that time.

The last trace of the Newberry level is found about mid-way on the west side of Lake Canandaigua. The next evidence of lake action, but representing the next lower level, is found to the north-

FIG. 23.

To face p. 100.

NEWBERRY DELTA ON BUTTERNUT (ENFIELD) CREEK. SOUTH SIDE OF STREAM, LOOKING NORTHWEST.

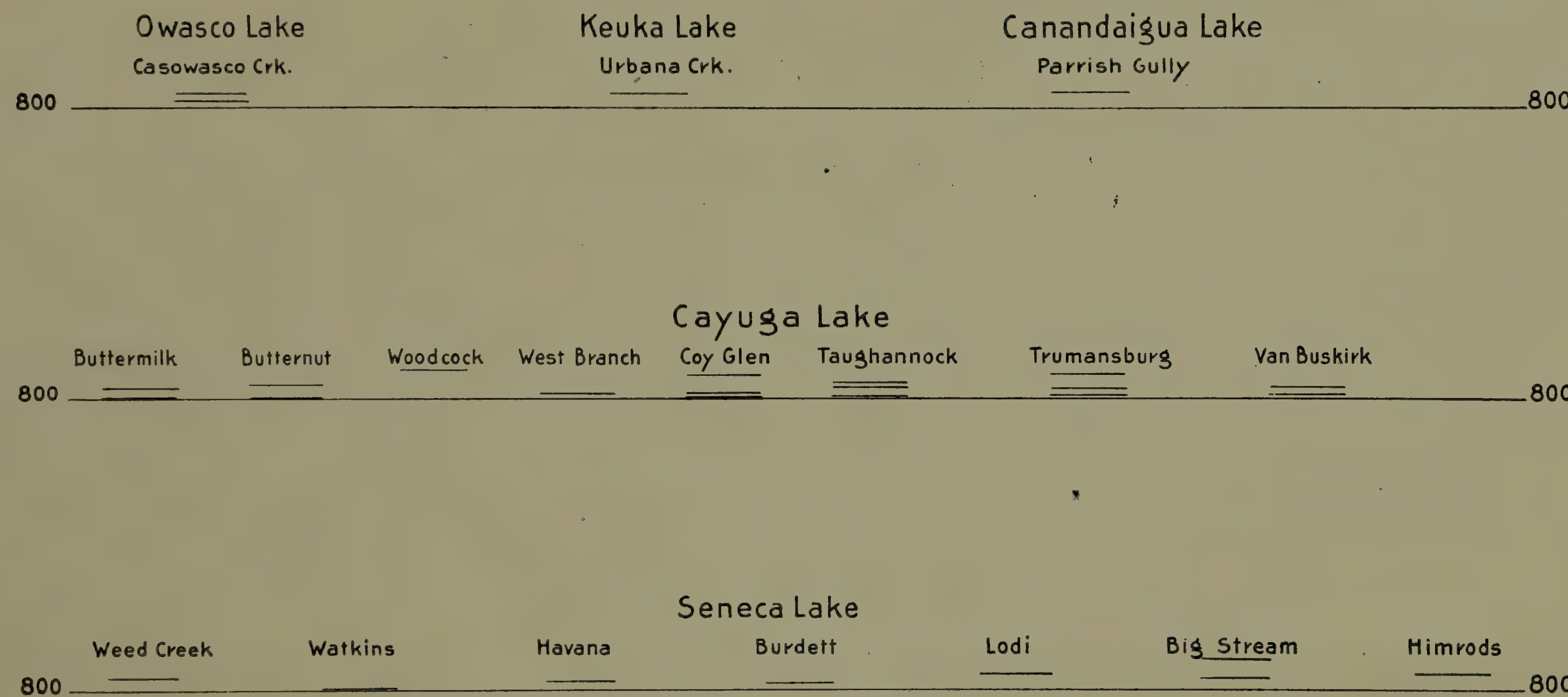
FIG. 24.

To face p. 100.

Newberry Delta on Butternut (Enfield) Creek. South Side of Stream Facing Nearly Due North.

To face p. 101.

FIG. 25



The Terrace levels of Glacial Lake Warren.

west in the vicinity of Victor, where the kames have been partially leveled by the static waters and, from this point eastward, an abundance of sand and silt deposits are found scattered over the plain skirting the northern end of the Finger-lakes.

Warren lake stage

Markings of lake level:

Owasco lake valley

Casowasco creek. 822 feet. 832 feet.

Keuka lake valley

Locke. 865 feet.

Moravia. 880 feet. 850 feet.

Urbana. 840 (?) feet.

Canandaigua lake valley

Parrish gully. 845 feet.

Cayuga lake valley

Butternut creek. 800 feet. 845 feet.

Woodcock stream. 890 feet.

West branch. 825 feet.

Coy glen. 804 feet. 826 feet. 864 feet.

Taughannock. 804 feet. 834 feet. [a] 843 feet.

Trumansburg. 807 feet. 827 feet. 868 feet.

Buttermilk. S. side, 800 feet. 892 feet. N. side, 834 feet.

Van Buskirk. 816 (h) feet. 826 (h) feet. 836 feet.

Seneca lake valley

Watkins. 803 feet.

Big stream. 830 feet. 880 feet.

Himrods. 842 feet.

Havana. 837 feet.

Lodi. 840 feet.

Burdett. 818 feet. 898 feet.

Evidence and history of lake. The next and last stage traced in the history of the Finger-lakes was connected with the Warren [b]

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a Accurately measured with an engineer's level and rod.

b This name was first proposed by J. W Spencer in Science 1888, 11, p. 49. For a description of its extent, etc , see articles by Spencer, J. W., Taylor, F. B., Upham, W., and others in Bull. G S. A., Am. jo. sci., and Am. geol.

(h) Indicates a slight halt in the waters, marked by slighter delta forms.

waters on the east, which then occupied the greater part of the Laurentian lake basin, and drained southward past Chicago into the Mississippi.

Workers in the Lake Ontario region generally agree that the withdrawal of the Ontario ice-lobe was northeastward. Accepting this as the true condition it necessarily follows that the Mohawk valley was still blocked by ice, which in fact has been proven by recent work. No drainage could, therefore, be effected to the eastward, unless it was subglacial. Furthermore, if the Ontario lobe retreated in a northeasterly direction, there was an abundance of land to the west uncovered by the ice, and sufficiently low in elevation to admit of free passage between the declining stage of Newberry and the beginning of the Warren waters. At this stage it is unnecessary, therefore, to consider a subglacial drainage to the eastward for these waters.

Fairchild [a], in his description and comparison of the kame areas of western New York has shown the effect of the Warren waters on the deposits in the form of terraces, and truncated sand hills, especially in the Victor-Miller's corners kame areas. (Figure 26) In speaking of these areas he says,[b] "Two strongly developed water levels are conspicuous; the higher between 850 and 900 feet, the lower about 700 feet above tide."

These levels show very close agreement with those traced by the writer in the lake valleys of the Finger-lake region and, therefore, have been correlated with the Warren waters. (See table above, also table opposite p. r84) Each level marked by the Warren waters, has apparently been recorded in the Finger-lake valleys. The higher or upper Warren stage varies between the limits of 800 to 860 feet in the Finger-lake region.

In 1895, Mr Frank Leverett [c] accurately traced the Warren level in western New York state, from Hamburg as far eastward as Crittenden, to which he has applied the name Crittenden beach. Professor Fairchild [d] has taken up the level at Crittenden, where its elevation was accurately measured one mile southwest of Crittenden and found to be 858 feet above mean sea level. It was then traced eastward past the town of Morganville at a distance of one and a half miles

a Journ. geol., 1896, 4, 129–159 ; Am. geol. 1895, 16, 39–51.

b Journ. geol., 1896, 4, 154.

c Am. jo. sci., 1895, 50, 1–20 ; specially p. 10–13.

d Bull. geol. soc. Am., 1897, 8, 272.

FIG. 26.

To face p. 102.

VICTOR KAMES. VIEW FROM TOBIN'S CORNERS LOOKING W. 15° N. "HOPPER" HILLS IN THE BACKGROUND. THE POINT OF VIEW IS UPON THE UPPER EROSION PLAIN OF THE WARREN WATERS, WHICH ALSO APPEARS IN THE DISTANCE ON THE RIGHT. (After H. L. Fairchild.)

northeast, where its altitude was again carefully taken with a level and found to be 880[a] feet; thence to Batavia and beyond to Caledonia into the Genesee river valley,[b] where its levels record one of the higher ancestral stages of the Genesee[c] lakes. From Geneseo it has been traced to Lima, the latter being the most easterly point where this level is identified by Mr Fairchild, the altitude being given as 877[d] feet. In the region of Lima the beach phenomena are represented by spits and bars connected with the drumlins.

The connection between the Warren waters and the same levels in the central New York lake region was to the northwest in the Miller's corners and Victor kame areas where the same levels in the Genesee valley[e] are recorded, and hence the coalescing of the Finger-lake waters and those of the Genesee valley at that point.

When the Warren waters were dismembered and Lake Iroquois born, the Chicago overflow was abandoned for a lower one to the east in the Mohawk valley at Rome, New York. These levels are also seen to be recorded in the kame areas as well as in the Genesee valley lakes.[f]

Lake sequence in the Finger-lake valleys

As soon as the ice commenced its northward retreat, uncovering the southern divide region in the lake valleys, the incipient stages of the highest lake levels in the respective valleys began. Of these, there were eight, named in order from east to west, glacial lakes Skaneateles, Groton, Brookton, West Danby, Watkins, Hammondsport, Flint creek and Naples. Each one had a separate outlet leading southward into the Chemung-Susquehanna drainage.

The Watkins, West Danby and Brookton stages were inaugurated about the same time. The West Danby lake was some 12 miles in length and only in existence sufficiently long for the ice to withdraw from the divide at Spencer Summit to Ithaca, when the Brookton and West Danby waters coalesced to form glacial lake Ithaca with the outlet shifted from the Summit to White church.

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a Bull. geol. soc. Am., 1897, 8, p. 276.
b " p. 277.
c " 1896, 7, p. 423-452.
d " 1897, 8, p. 280.
e " 1896, 7, p. 423-452.
f "

This would mean a fall of some 50 feet in the Danby waters, and while no evidence has been found favoring such an hypothesis, the subsidence from the West Danby to the Ithaca level was probably sudden. The Ithaca level was maintained for a much longer time, since large and well defined terraces are found marking its level in both arms of the valley. This meant a retreat of approximately 25 miles to the north before the Ithaca lake stage was closed. At the same time and co-extensive with, but separate from glacial lake Ithaca, was glacial lake Watkins, which was rather a long-lived lake, as it endured for a length of time sufficient for the ice to withdraw from the Horseheads divide to the town of Ovid, a distance of some 35 miles. When the divide in the Ovid region was reached by the retreat of the ice occupying Cayuga and Seneca valleys, the Ithaca lake stage was closed by a rapid falling of its waters to the level of the Horseheads divide. The drainage was then shifted from the White Church to the Horseheads col, indicating a fall of some 75 feet from the Ithaca to the Newberry level.

This marks the beginning of glacial lake Newberry. At the same time the Hammondsport level was abandoned and its waters fell to and coalesced with those of lake Newberry, then formed by the united waters of lakes Watkins and Ithaca discharging south through Seneca valley. The change in level from the Hammondsport to the Newberry stage was not a very sudden one, but rather slow, marked by definite, intermediate terraces found on the same stream between the two levels. This stage in the Newberry level was held until the ice had retreated sufficiently far northward to open up the low lands at the outlets of Canandaigua and Flint creek on the west, and Owasco and probably Skaneateles on the east; when the waters marking the higher levels in the southern portions of each of these lake valleys fell to the level of and united with the Newberry stage then existing in Cayuga, Seneca and Keuka lake valleys. When this final coalescing of the waters from all the lakes occurred, lake Newberry occupied its maximum extent, which was held until the Victor and Miller's corners area was uncovered. The Newberry stage was then closed by a falling of its waters to the Warren level, when the outlet was shifted from Horseheads to the Warren overflow at Chicago. The subsidence between the Newberry and Warren levels was gradual, as shown in terraces found only at a few feet below the

former level down to the lowest terraces of the latter stage. It is especially noteworthy that, in the coalescing of the waters in the several valleys when the outlet was shifted from one col to the next lower, the change of level of the subsiding waters was not by a sudden fall, but generally more or less gradual. This is especially noticeable in the case of the three local lakes, Watkins, Hammondsport and Naples, and the general lake Newberry. The condition of gradual subsidence in the waters is marked by distinct terraces existing at intermediate levels between those marking the two stage limits. A comparison of the higher stages in the Cayuga basin with that of Lake Cayuga, based on the difference in elevation of the outlets, is shown in the following diagram.

Fig. 27

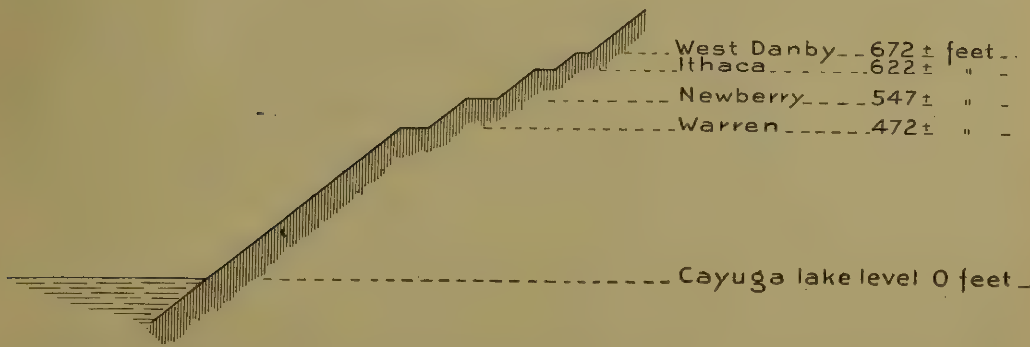


Diagram showing the relation of the higher lake levels to that of Lake Cayuga in the Cayuga lake valley. Based on the difference in elevation of the lake outlets.

Features in the development of the terraces which have rendered their correlation difficult

The principal and all important elements concerned in the development of lake shore features are time, depth of water and size of lake, coupled with that of stream volume and load. Of course, the longer the waters are held at one level, other things being equal, the larger, more distinct and perfectly developed will be the shore lines. Relying on this last principle some inference can be drawn relative to the duration of an extinct lake's waters while sustained at a certain level: that is to say, the degree of development of the lacustrine shore features will be proportional to the duration of the extinct lake, or, the time during which the waters marked one continuous level. It should follow therefore, from the above that the

strongest shore markings should exist, where the time existence of the lake was the most protracted. In applying this principle to the valleys in question we find very close agreement.

The most pronounced and typical class of terraces is found in the southern portions of each of the existing lake valleys, where the lake endured the longest. As we travel northward the terraces very rapidly grow fainter and less pronounced, until near the northern valley extremities they are lost altogether, no record of this character being left to mark the history. An element which has attended the development of the stronger terraces in the southern parts of the valleys, is that the most vigorous streams are confined for the most part to this zone. While this is recognized to be one of the prime factors in terrace growth, the terraces in the Finger-lake valleys do not rigidly adhere to the size of the parent stream, hence, the other factors concerned must in some cases have been of equal if not greater import in thus regulating the growth of the abandoned delta terraces. A prominent element thus concerned in this region, and elsewhere noted by workers on glacial dammed lakes, is the following: the farther removed from the northernmost extension of the ice while damming the waters (provided, of course, the blocking occurs in a north and south valley with a northward ice recession), the more accentuated are the terraces; lake depth, of course, being always an important factor. In other words, terrace accentuation is commensurate with lake life.

A study of the table of terraces opposite p. r84 shows at a glance that while the terraces admit of fairly good correlation they are not found at the exact elevation for the same level on each stream, but vary between certain admissible limits. Their location in case of Cayuga and Seneca valleys as well as the remaining Finger-lake valleys, is certainly most unfavorable for maintaining their correlative heights throughout.

Discussion of the lower terraces

Lower terraces occur at successive elevations on all of the streams from which the higher levels have been noted and discussed. Not only are they found on the same streams with the higher terraces, but also on a large number along which the higher levels have not been found. Wherever streams of any size enter the lakes, this

FIG. 28.

To face p. 107.

Lower Delta on Coy Glen. Point of View is Looking West, from the West Side of Cayuga Inlet.

lower succession is found, extending in some cases within a few miles of the lake outlets. They can be traced from the deltas now forming opposite the stream mouths entering the lakes, up to the Warren level. They have not lost any of their distinctive delta characteristics, and many of them stand out as conspicuously and are as large and strongly developed as any found among the higher levels. (Figure 28). While nearly all of these have been measured, the time available has been insufficient to study and work out their correlation with one another and the corresponding drainage channels. No attempt therefore, will be made to work out the different stages among them in the present paper, but doubtless they will form a fitting theme for some future worker, after which the complete Finger-lake history may be written.

On Lake Seneca the lower levels have been noted within three to five miles of the lake outlet on the most northerly tributaries entering from the west side. The most northerly trace of the lower terraces on the west side of Cayuga lake was found on the stream entering at Sheldrake point, some 21 miles north of Ithaca. It is but a weakly defined terrace occurring on the north side of the stream at an elevation of 488 feet above tide and marks the site of a cemetery.

Some of the lower terraces are as large and strongly defined as any among the higher levels, which probably indicates for the former a rather longer and more protracted halt in the waters. So far as study was possible the conditions of water level, etc., were interpreted as being the same as worked out for the terraces marking similar levels among the higher stages.

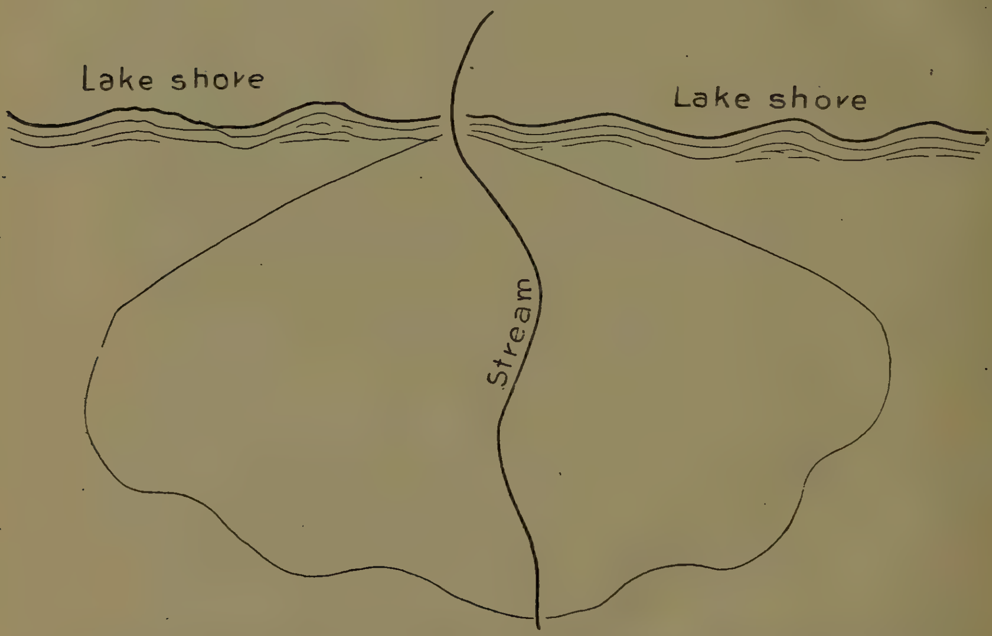
Among the lower levels in the general lake succession a change in the waters took place, whereby they were partly dismembered. The exact time of this change has not yet been worked out, but it happened after the Warren levels were abandoned, and probably not until the shifting of the outlet of the Great Lakes to Rome and the Thousand Islands by way of the St Lawrence river. It is possible that during a part, if not all of the time, during which the Great Lakes were draining through the Mohawk at Rome, the waters of the Finger-lakes, or at least some of them, were still united with and formed a part of that system.

This point, when established and finally settled, will be a very interesting as well as needful one in the history of each of the lake systems.

Comparison of the abandoned deltas with the deltas forming in the present lakes

In all normally formed deltas the interaction between stream and lake tends to the production of a fan shaped outline in the deposition of the stream borne material. The delta apex is turned up stream or landward with the point of maximum convexity in its periphery practically opposite. (Figure 29)

Fig. 29

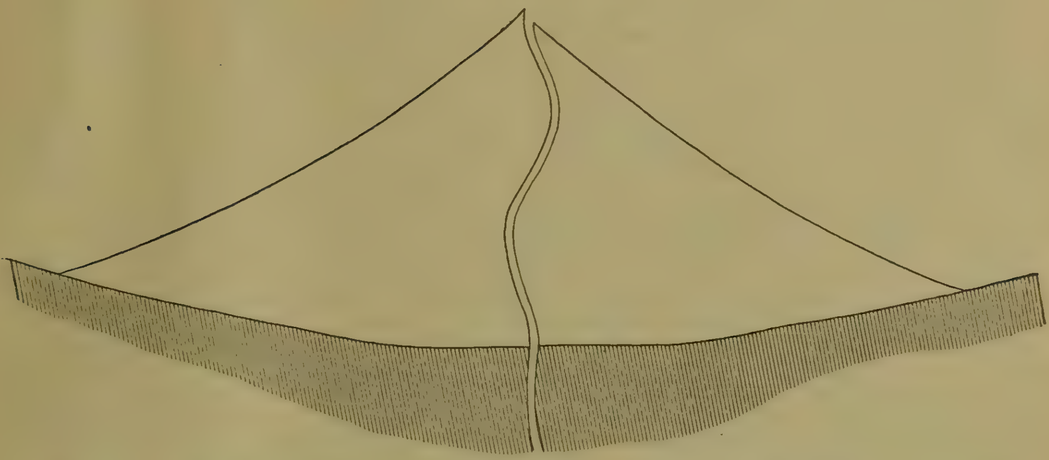


Outline of the normal delta as exemplified in the higher level deltas of the Finger lakes

The opposite outline or that of a V-shaped mass[a] in delta form may result in several ways, dependent upon the direction of the dominant current. In this type the apex is pointed lakeward with one side toward the land. All gradations in modified forms may be obtained between these two extremes, dependent upon the variation in the forces concerned. (Figure 30)

[a] Gilbert, G. K., The topographic features of lake-shores. Fifth ann'l report, U. S. G. S., 1883-84, p. 108.

Fig. 30



Outline of the typical V-shaped delta. The type toward which the deltas forming in the present lakes are tending. The mainland is cross-hatched.

A close examination of the deltas marking the former higher lake levels indicate an almost universal tendency toward the normally formed delta, in outline. Their forms were more or less fan-like, with apex toward the land and periphery turned lakeward. In marked contrast to these, is the type of deltas in some cases forming in the present lakes, in which the V-shaped outline, or the "delta cusp" [a] type, is strongly exemplified — with apex turned lakeward and one side toward the land. The apices of some point directly lakeward, of others southward, giving an intermediate form and indicating a prevailing current in that direction.

The difference in the two classes of deltas, as above distinguished, can probably be accounted for, mainly, upon the ground of age and the conditions prevailing for the two periods of delta formation, which must have been of an opposite nature.

Differential movement in the Finger-lake region

No perfectly reliable results could be obtained for the differential uplift in this region, since the desertion of the shore lines by the static waters. While the terraces show a fairly good correlation they most certainly reveal some of the conditions under which they were constructed, such as, extreme variableness in the stream grades,

a For the different ways in which "delta cusps" may be formed, see,
Gulliver, F. P., Cuspate forelands.
Bull. geol. soc. Am., 1895, 7, 399–422 : specially 417–21.

rapid deposition of material, and the existence of the several stages at any one level, which render the figures uncertain and probably of indefinite value in such computations. Another factor which enters into the result is that of terrace measurement. In taking the elevations three sets of measurements in different positions were taken for each terrace : the first, was from 10 to 15 paces from the top and front edge of the terrace; the second, was on the top and middle; and the third, was on top and at the back of terrace. This method was adopted in order to secure some uniformity in the results, inasmuch as the true position of the water line could not be established for any one of the terraces. The results given in the tables, both numerical and graphic, represent the measurement taken on the delta top at a distance of some ten to fifteen paces back from the frontal edge. It at once becomes apparent, that the variation will be greater or less according to the factors concerned in the terrace construction, the most important one of which is stream grade and bottom slope. If a delta is built at the mouth of a stream entering a static body of water whose shore slope is precipitous, the delta front will necessarily be lower than its correlative built by a stream entering where the slope is slight and gradual. This element is the principal one causing the variation noted in the different terraces, marking the same level in the Finger-lake region. As previously stated, the streams entering the lakes and upon which deltas are found, show a considerable variation in stream gradient.

No figures relating to strict accuracy can be given as a reliable computation for the supposed differential movement in the Finger-lake region, but certain latitude must be allowed, owing to the complexity of the factors concerned in the shore-line development. Nevertheless, some data have been collected of considerable interest and probably not without significance.

Three of the largest and therefore principal successive lake stages studied for the two largest valleys of the series, namely Cayuga and Seneca, are selected for the test. In both cases the most southerly stream upon which is marked, with the least doubt, the three levels, and in the same way the most northerly stream for the same lake basin have been selected. In case of Cayuga valley, the three levels are best defined on West branch which is the most southerly stream for this basin representing these levels and have the

following elevations above sea level; lake Ithaca 985 feet, lake Newberry 920 and lake Warren 825 feet. The same levels marked on the most northerly stream which is Trumansburg creek, have the following elevations; lake Ithaca 1047 feet, lake Newberry 919 feet and lake Warren 868 feet.

In a comparison of the above figures a difference of 62 feet in elevation is noted for lake Ithaca in a northward direction, a difference of —1 foot for lake Newberry, and of 43 feet in the same direction for lake Warren. The distance between these two streams, which are on the west side of the lake and in an almost due north and south line, is some 20 miles. The differences correspond therefore, to a gradient of 3.1 feet; —.05 feet; and 2.15 feet per mile, respectively, for the three levels. The figures show furthermore that the levels are not equidistant from each other in the two localities, but indicate in the case of lakes Ithaca and Warren an increased northward rise, while a small negative result is indicated for lake Newberry.

A similar comparison is likewise given for the same levels in the Seneca basin. The streams best suited for the comparison are unfortunately not on the same side of the basin, but the width of the valley in cross-section is not very great and probably will not materially affect the results, since the streams are approximately in a north and south line. Watkins glen stream is the most southerly one showing these levels with the following elevations; lake Watkins 969 feet, lake Newberry 925 feet, and lake Warren 803 feet. The elevations corresponding to the same levels on Lodi creek are lake Watkins 1015 feet, lake Newberry 940 feet and lake Warren 840 feet. The figures here indicate a general northward rise in the levels of the three lake stages. In the case of lake Watkins the difference is 46 feet, of Newberry 15 feet, and of Warren 37 feet, corresponding to a northward rise of 3, 1 and 2.5 feet per mile for the respective levels. As in the case of the Cayuga basin, the same levels in the Seneca basin show an unequal distance between the levels for the two streams and a rising to the north.

The apparent warping of the shore-lines, if such it be, is even more irregular when shorter distances are taken, the gradient being sometimes greater and sometimes less, than is shown above.

The element of chance seems so large in the above calculations, for reasons hitherto stated, that they must be taken more as a suggestion than as a statement of fact. As a rule however, the figures given in the table of terraces opposite p. r84, indicate a prevailing increase in elevation to the north for the different lake levels, and are, the writer believes, strongly suggestive of a change in level of the shore-lines, but just how much is difficult to say.

SUMMARY OF CONCLUSIONS

All evidence, so far worked out, shows the ancestral lake history in the post-glacial development of the present lakes to be a rather complex one. A large number of lake stages are represented with many outlets differently located. Briefly summarized, this paper after a statement of the preliminary considerations and facts, and a discussion of the most plausible hypotheses, whereby the phenomena might be accounted for, has, I believe, satisfactorily eliminated all but one hypothesis. This one successfully meets the conditions supplied by the facts and conclusively points to a two-fold lake stage in the Finger-lake region. The facts supporting this hypothesis, briefly stated, are

1 Shore lines. (a) Constructional forms– delta terraces. (b) Some probable destructional forms cut in the soft-till deposits which are in part resulting modifications probably due to wave action.
2 Overflow channels.
3 Lacustrine clays and silts.
4 Probable iceberg deposits.

When the ice had withdrawn from the southern divide region, the initial stage was introduced, or that of local lakes, of which there were nearly a score in number. These local lakes filled and occupied the southern portions of each of the present lake valleys with overflows that were entirely separate from and independent of each other.

A general lake condition immediately succeeded the period of local lakes upon a farther northerly recession of the ice, when the local lakes coalesced to form one large expanse of water, closing all but one outlet which was subsequently shifted to different parts of

the lake divides, as the static waters were forced to abandon one level for the next lower in the exposing of lower cols by the ice recession.

It has been pointed out that some time after the Warren levels were abandoned in the Finger-lake valleys, a change was inaugurated, causing a partial dismemberment of the waters. This was succeeded by the present system of local lakes. The lake sequence in the Finger-lake region then becomes:

1 An epoch of local lakes; the initial stage filling the extreme southern ends of the valleys with free drainage southward.

2 An epoch of general lakes; when the waters of the local lakes were united into one broad expanse with drainage shifted to different parts of the basin.

A final and second epoch of local lakes, to which the present lakes belong; occupying the middle and northern portions of the valleys with free drainage northward.

The conditions further indicate a brief existence in the static waters sustained at any one level. This is made manifest from the character of the shore phenomena. A condition must have prevailed, as suggested by the shore material and deposits, when the streams delivered large volumes of water and were given accordingly large quantities of material for transportation which also, was probably accompanied by rapid deposition. The slight development of the probable destructional shore features and the entire absence of constructional beaches without the faintest trace of the latter found at any one of the levels are certainly highly indicative of brief halts at any one level. The faint and slight development in the moraines to the north of the "Moraine of the second glacial epoch" and the slight depth to which the overflow channels have been eroded, would farther strengthen the testimony favoring the short duration of any one of the numerous lake stages. While the waters were sustained at any one level for a comparatively brief time they were probably held at one continuous level during some stages for a longer period of time than at others, as manifested in the unequal strength of the deltas and overflows. The characters of these point to a longer stay of the waters at the Newberry level than at any prior or subsequent level studied.

In the falling of the waters from one stage to the next lower, the subsidence was generally slow and gradual, leaving records of

distinct halts between the two definitely defined stages. This condition was not persistent throughout every stage, as some of the earlier ones in the local lakes strongly suggest a rapid falling in the waters.

A study of the terrace elevations seems to indicate a general northward rise in the shore-lines of the different lake stages, which suggests a differential uplift in that direction, since the desertion of the levels by the waters. The figures furthermore, indicate not a uniform uplift, but rather a kind of warping, better described as "buckling" in the gradient, shown in the unequal distances between the same levels in different places. Also, the gradient is not the same for any two levels.

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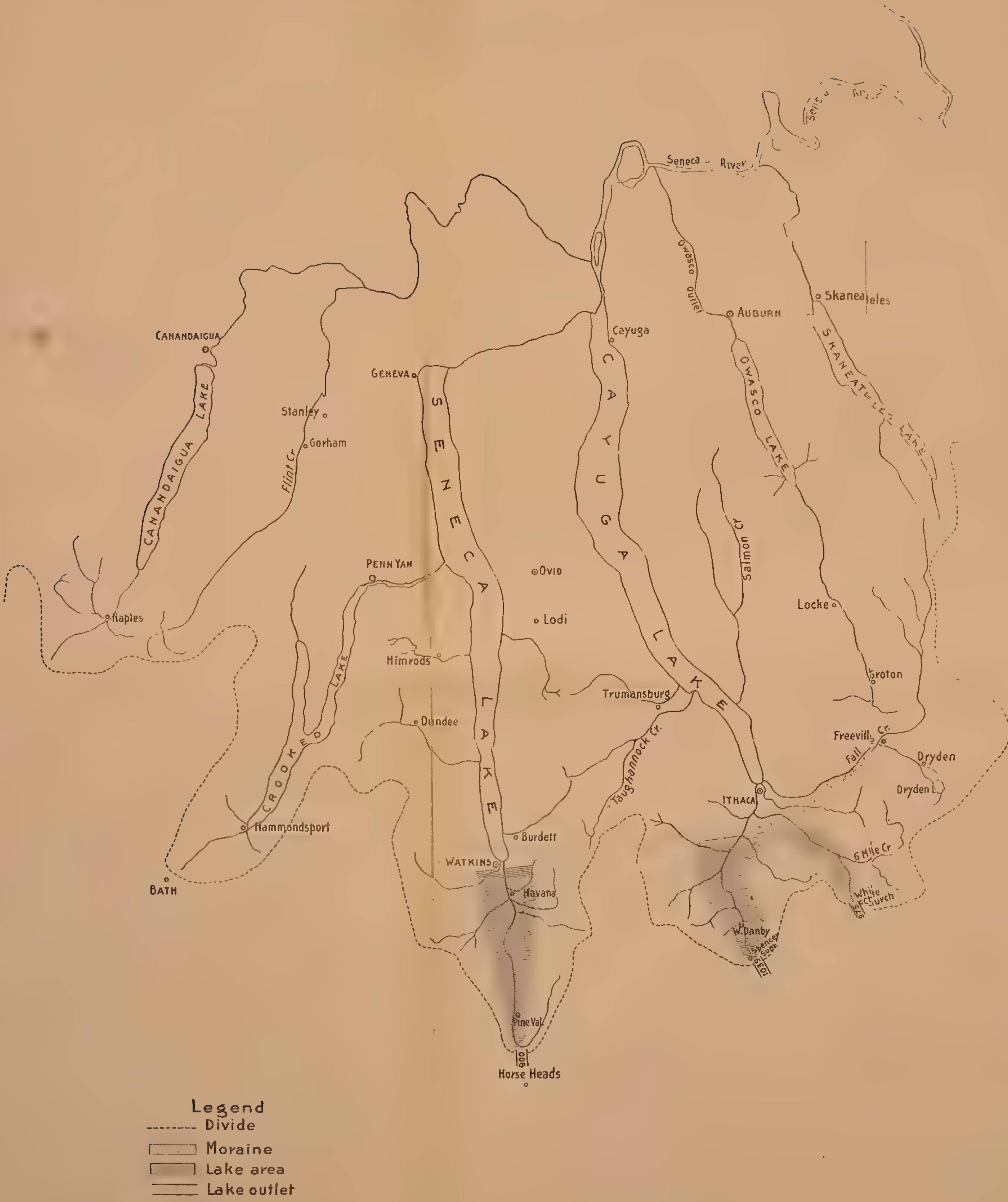
THOMAS LEONARD WATSON

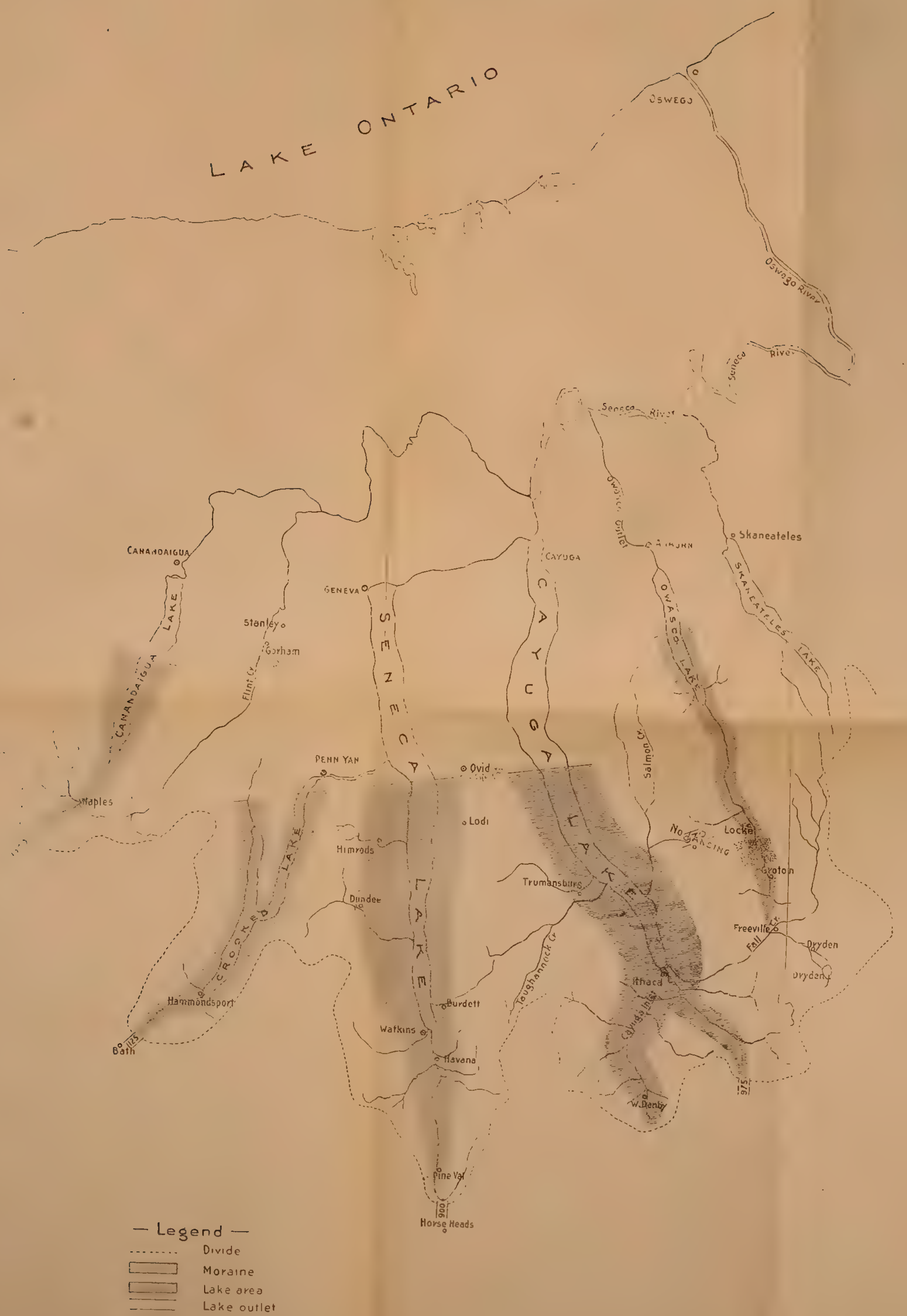
ITHACA, NEW YORK, *June* 1897

MAP 1.



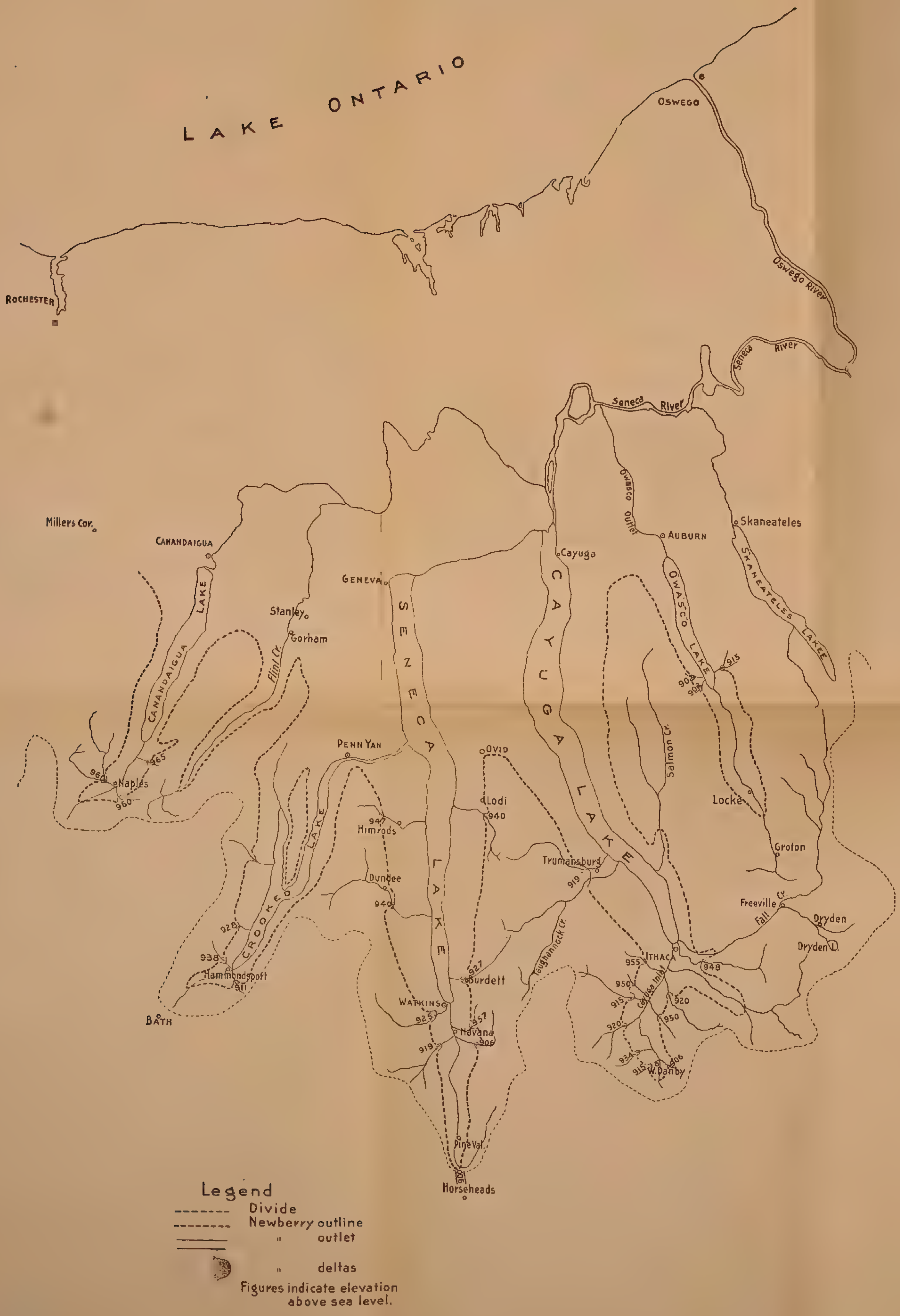
Map Showing the Areal Extent of Glacial Lakes West Danby and Brookton and the Incipient Stage of Glacial Lake Watkins.

BY THOMAS L. WATSON.



Map Showing Approximately the Maximum Levels of the Local Glacial Lakes Occupying the Present Finger-Lake Valleys.

BY THOMAS L. WATSON.



Map Showing the Approximate Areal Extent of Glacial Lake Newberry.

By Thomas L. Watson.

APPENDIX C

THE TALC INDUSTRY OF ST LAWRENCE COUNTY, NEW YORK

BY

J. Nelson Nevius

THE TALC INDUSTRY OF ST LAWRENCE COUNTY, NEW YORK

BY J. NELSON NEVIUS

Nearly all the talc mines of this region are located in the village of Talcville, town of Edwards; a few are in the town of Fowler, which adjoins Edwards on the west. The intervening country, for a distance of five miles or more, has been prospected in a superficial manner, but without much success.

The International pulp co., which is the largest operator, absorbed the Adirondack pulp co., the Agalite fiber co., the Natural Dam pulp co., the St Lawrence pulp co., and the Asbestos pulp co. The United States talc co. is the second largest operator. The other operators are, the American talc co., Kellar Bros. and the Columbian talc co.

The word "pulp" occurring through this article, refers to pulverized talc—the finished product of the talc mills. It is distinct from the use of the word "pulp" in the eastern part of the state, where it refers to pulverized poplar wood. A third use is made of the same word in the paper mills, where it refers to the digested paper before it is run out on the drying felts.

Mines at Talcville. There are 12 mines at this locality, though half of them are either abandoned or are at present idle on account of the dulness of trade. They are situated in three groups along an approximately east-northeast line, having a slightly crescentic sweep, the groups being located on the sides of low hillocks separated from each other by strips of marshy land. As the strike of the country rock is almost identical with the direction of the line between the mines it is possible that the latter may all be located on the same seam of talc, which may be continuous over the entire distance.

Opposite the railroad station at Talcville a ledge of pink gneiss is exposed in a railroad cut. The strike here is east-northeast and the dip is about 58° north-northwest. At other points in the vicinity the dip varies considerably from this angle, and the strike varies to a less extent.

The country rock in the vicinity of the mines is almost exclusively a massive gray or pink gneiss which is included within the crystalline limestone belt of this region. The mines are similar in general character, although some differences can be noticed both in the walls and the products.

Mine No. 3, of the International pulp co. This mine is entered by a shaft which follows the dip of the country rock at an angle of about 50°. The cross section of the shaft is variable, but is nowhere less than 6 by 8 feet. Timbering is necessary only at weak points and where the shaft is unusually wide, as the rock is massive gneiss, which gives place, as the seam is approached, to massive, white, tremolitic dolomite in the hanging wall. The bottom of the mine is 300 feet below the surface, though the talc seam was struck at a less depth. The shaft extends to this depth in order to get below an old mine which had caved in. The drift slopes gently upward away from the foot of the shaft to give drainage and to facilitate moving the loaded cars to the shaft. The hanging and foot walls are nearly parallel and dip at an angle of 50°. The seam of talc, which varies in thickness from 15 to 25 feet, and is of unknown width, has been removed for a distance of 250 feet along the strike of the walls and a distance of about 60 feet along their dip.

At the breast of the drift the talc has the appearance of a mass of ice covered with an inch or two of snow. It is extremely tough, so that blasting is necessary.

The talc, in large masses, is thrown into ore cars which run on iron rails from the breast of the drift to the foot of the skip-way leading to the surface. Here it is dumped into the iron skip-cars which are hauled out of the mine and on to a trestle 35 feet in height, by means of a cable from the surface. On this trestle the talc is dumped into another hand car and pushed to the railroad where the talc is loaded on platform cars which convey it to the grinding mills. From this trestle the waste is dumped. Plate 1 is a view of the end of the trestle, and also shows the waste dump, and the skip-way running down into the mine. It also illustrates the position of the mine on the side of the hillock.

Where the shaft first cut the talc seam, a drift was started in the same direction as the lower one now in use, but it was too close to

PLATE I. To face p. 122.

J. N. Nevius, photo.

MINE NO. 3, INTERNATIONAL PULP CO., SHOWING DUMPING SHED, WASTE DUMP AND SKIPWAY LEADING INTO THE MINE.

PLATE II.

To face p. 123.

J. N. Nevius, photo.

Skipway and Dumps of Mine No. 5, International Pulp Co., at Talcville, N. Y., Showing Skip Car Coming Up.

PLATE III. To face p. 123.

J. N. Nevius, photo.

Engine House and Dumping Shed of Mine No. 5, with Mine No. 6 in the Background. Talcville.

the spot where the old mine had caved in and was abandoned. It was subsequently connected with the main drift by an uplift along the seam, leaving a supporting pillar which gives an excellent section of the talc seam.

Pumping is necessary, and when a mine is abandoned it soon fills with water to within a few feet of the surface.

Mine No. 5, of the International pulp co. This mine is located on the east side of the same hillock as mine No. 3, and is about 500 yards distant from it. It is not quite so deep as its neighbor and is operated on two levels. The skip-way is considerably steeper, and the talc on coming from the mine in the skips is automatically dumped into another car and run down to the railroad by gravity, the empty car being hauled back by a cable. Plate 2, shows the entrance to mine No. 5, the waste dump, a loaded car on the skip-way and the track connecting with the railroad. The rails of the skip-way are bent to a horizontal position as they enter the shed. The front wheels of the car follow these rails, but the rollers projecting beyond the rear wheels are caught by supplementary rails and the rear of the car is thus carried upward, dumping the contents into the third car on the track below.

A slight difference in texture can be noticed between the best grades of talc from mines Nos. 3 and 5, in fact this statement is true of almost all of the mines.

Plate 3, shows the engine house and dumping shed of mine No. 5 in the foreground, and mine No. 6 in the distance.

Varieties and occurrence of the talc. Two grades of talc are mined. (1) "First quality fiber." This is a compact rock, somewhat variable in appearance. Its two chief types are characterized as follows: (a) distinctly fibrous in structure, with clusters of fibers ramifying in all directions, and usually of a grayish tint; (b) lacking somewhat in the fibrous appearance, as the fibres tend to run in one direction, and usually of a light sea-green tint. Both types when crushed form a snow white pulp. (2) "Second quality fiber" may be either (a) "gritty", when an otherwise first quality material contains some harder impurity, which is usually tremolite or some other member of the amphibole group; or (b) "scaly" when it does not possess a fibrous structure and consequently tough charac-

ter and is flaky and brittle. This last variety is more predominant in the mines at Fowler than in those at Talcville.

The second quality talc is useful only to a limited extent, as the pulp must contain but little gritty or scaly material.

The walls of the talc seam (or seams) were nowhere observed to be the gneiss which outcrops between the mines. The talc sometimes has an abrupt contact with a highly crystalline white tremolitic dolomite; or there may be an inch or two of williamsite between the two. This occurrence is probably due to faulting. Or it may pass gradually from first quality fiber, through second class gritty material and fade gradually into a wall of tremolitic dolomite or schist This condition occurs in mine No. 5 where the gritty talc grades into a massive amphibole rock.

C. H. Smyth jr., in vol. 17 of the *School of mines quarterly* describes the occurrence and formation of the talc. He says "in most accounts [a] it is stated that the talc forms a clearly defined vein with walls of granite or gneiss, the vein being penetrated by, and including horses of, tremolite."

"According to the writer's observations, the talc occurs in the form of beds, lying wholly within the schist of the limestone formation.

They dip and strike with the rest of the formation and have schist for both foot and hanging walls, sometimes with an intervening thin layer composed largely of quartz. There is little in the character of the beds to suggest a vein formation, while the walls of gneiss and granite are wholly lacking."

As to the origin of the talc, Prof. Smyth bases his conclusions on the microscopic examination of the talc, and he points out that the talc is an alteration product derived from beds of tremolite schist in the limestone, and all gradations between the talc and the unaltered tremolite can be found. In conclusion he says, "The deposits of talc are of complex origin and the process which has led to their formation consisted of three distinct stages. First, there was formed an impure siliceous and magnesian limestone. Second, this rock underwent metamorphism and was converted into enstatite and

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a A. Sahlin, Trans. Am. inst. M. E. 21. p. 583.
A. Sahlin, The mineral industry. 1. p. 435.
C. A. Waldo, The mineral industry. 2. p. 603.

To face p. 125.

J. N. Nevius, photo.

EXPOSURE OF GNEISS AT THE TALC MINES AND ENTRANCE TO AN ABANDONED OPEN MINE, TALCVILLE.

PLATE V.

To face p. 125.

J. N. Nevius, photo.

A Pillar in the American Talc Co.'s Mine, Near Fowler, Showing a Section of the Talc Bed. Dip of the Beds 50°.

tremolite schist. Third, this schist, by the action of water, charged with C O , was converted into talc."

Plate 4 shows the association of the gneiss and the hanging wall of the talc deposit.

The observations of the writer, though brief, fully accord with the theory of origin advanced by Prof. Smyth.

Mines at Fowler. The American talc co. operates mines and a mill on the Belmont farm near Little York, town of Fowler. The principal mine, having been idle, had become filled with water which was being pumped out (July 1897), and was not accessible below the second level. Judging from what could be seen, this mine differs from the others only in that the talc seam is thinner, averaging 15 feet, and this fact necessitated working it on several levels, pillars being left at regular intervals to support the hanging wall. The pillars present excellent cross sections of the seam and show its association with the walls. Plate 5 shows one of these pillars. The contact of the talc seam with both walls is strongly marked.

Another opening is being made within a few hundred feet of the old mine, to cut the same seam. It reached scaly talc at a distance of 40 feet below the surface, which graded into first quality material 10 feet lower. The mill is within a couple of hundred yards of the mine, and the talc is conveyed to it in cars operated by hand power.

The Columbian talc co.'s mine on lot 106, Little York, town of Fowler, cuts a seam of talc over 80 feet in width, and the drift which follows the seam, is entirely surrounded by talc, neither wall being visible. The mill is about five miles distant from the mine.

The pulp mills. The majority of these are located along the Oswegatchie river about midway between Talcville and the town of Gouverneur. Some of the smaller mills are operated by water power, but the majority use steam power exclusively, or combine the two. The mills are several miles from the mines, and the Gouverneur and Oswegatchie railroad transports the raw material to the mills and carries the pulp to the main line.

The operations are practically identical in all the mills.

Mill No. 3 of the International pulp co. This mill is located at Hailesboro, about 1½ miles east of Gouverneur. It is one of the

company's standard mills, of which they operate several others scattered to the eastward in the direction of the mines. In their largest mill, "no. 6," they are experimenting successfully with a secret process by which grit and other impurities are separated from the pulverized talc, thereby producing a finer grade of stock.

Almost the entire process of pulverization is performed by automatic machinery, so that after a supply of the raw material is prepared by the day shift, the mill runs itself all night except for the final operation of filling and weighing the bags of pulp and loading them on the cars.

The raw talc varies in size from dust to masses two feet, or more, in length. As already mentioned, there is some difference in color and considerable difference in texture and quality of the products of the different mines; but they are so mixed by experienced workmen that the finished product is uniform both in appearance and quality.

Process of pulverization. The process of pulverization consists of seven operations. First, the large masses of talc are broken with a sledge. Second, the talc is crushed by a pair of slightly corrugated steel rolls, 30 inches in diameter. Third, it is conveyed by a belt to bins on the top floor of the mill. Fourth, from these bins it feeds into a Griffin mill on the floor below. Fifth, it is loaded into large hopper shaped bin-cars which are used for storing as well as conveying the material. Sixth, the contents of a bin-car are placed in an Alsing cylinder, along with a quantity of water-worn quartz pebbles, the abrasion of which, as the cylinder revolves, completes the pulverizing process. The talc pulp is sifted through a grating in the cylinder which retains the pebbles. Seventh, it falls into a bin with a tapering bottom which joins the bag-filling device on the main floor. This machine loads approximately 50 pounds of the talc pulp into a paper bag placed under the spout by hand, and packs it by means of a revolving disc acting against the rising platform which carries the bag. The weight of the bag is then corrected on a scale, and the bag is loaded directly on the car for shipment. Two men are needed to fill and handle the bags.

There are two bag-filling machines, but at the time of this visit

the mill was not running to its full capacity, and but one was in use. It filled, on an average, three 50 pound bags per minute.

The pulp is also packed in cloth bags containing 160 pounds each.

Value and uses of the pulp. The pulp formerly sold for about \$30 per ton, but recent competition has reduced the price to about \$7 per ton, and has so nearly destroyed the profit that many of the smaller concerns are fast being driven out of the business.

The pulp is prepared in several grades and each company has its own special names for the various grades.

The greatest demand for the pulp comes from the paper industry. It is used as a filler in many qualities of paper, but the greatest consumption is in the manufacture of newspaper stock, for which purpose it is mixed with wood pulp. The talc pulp thus used is a very finely pulverized grade, designated "Finished asbestine pulp" by the International pulp co., and "Fine cylinder stock" by the United States talc co.

A less finely pulverized ("fluffy") grade is produced by omitting the process of grinding in the Alsing cylinder already mentioned. This grade is used with asbestus (chrysotile) fiber in the manufacture of "asbestus paper," "asbestus packing," etc., and is designated "Special asbestine pulp" by the International pulp co., and "No. 1 Buhr stock" by the United States talc co.

Talc pulp is used also to some extent in the manufacture of certain paints and wall plasters.

Vol. 5 of the "Mineral Industry" states that the production of this material for the year 1896 was 45,000 short tons, valued at \$315,000.

APPENDIX D

THE HISTORY OF CAYUGA LAKE VALLEY[a]

BY

J. Nelson Nevius

[a] Written in 1894 as a requirement in research work at Cornell university.

CONTENTS

HISTORY OF CAYUGA LAKE VALLEY

By J. Nelson Nevius

Cayuga lake, in the central part of New York state, is the largest of the well known "Finger lakes"—so named from their long slender form and their peculiar radial grouping.[a]

Except in regard to size, these lakes bear a striking resemblance to each other; they are all long in comparison with their width, very deep, have similar rock walled shores, and their outlets are toward the north, except in case of one or two of the smaller ones.

Cayuga is about 40 miles long, with an average width of 2 miles, the maximum being 3½. Its depth is variable, the maximum being 435 feet—and a considerable portion of the bottom is below sea level. The lower half extends north and south, and the remainder is northwest and southeast, giving a slight curve to the form—a noteworthy feature being that the portion having the north and south axis averages nearly a mile wider than the remainder.

Except at the northern end, the shore is either a perpendicular wall, often 50 feet in height where the bed rock reaches down to the beach, or a more gentle slope where the rock has been removed, and the shore is of gravel and loose material. These conditions alternate along both sides as far north as Union Springs, where other conditions set in, and it is the rule, (though there are exceptions) that where a rock wall appears on one side, directly opposite will be found the gradual slope due to the non-appearance of the rock. From the shore-line the land rises steeply at first, then more gently, till it reaches a height of some 500 feet above the lake.

Where it has not been cut away by stream erosion, there is a deposit of glacial drift on the hills, to a depth of from 5 to 25 feet. Every few hundred yards, streams of various sizes have cut through the drift and into the rock, the depth depending upon the size of the stream.

The southern end of the lake is about one and a half miles wide and is cut off very squarely by the low alluvial deposit upon which the city of Ithaca stands. Through the center of this low land, flows the "Inlet," which is the aggregate of all the streams emptying into the valley north of the Danby divide, and south of the

a For map of this region see map no. 3, appendix B.

lake. Alluvium completely fills the valley between the East and West hills for a distance of two and a half miles, and rises with an almost imperceptible slope from the lake to its southern end. It is a large delta deposit which has filled in the end of the lake, and is somewhat elevated along the sides by material washed down from the hills. Proof of this is seen in several places. From the southwest corner of the lake the rock cliff continues inland, maintaining its abrupt features as an escarpment for a quarter of a mile, and gradually rounding off as it has weathered away, or has been cut down artificially. Along the base of the cliff are found the typical shore line pebbles at almost any point, especially if searched for beneath the soil. Moreover the flat has the typical stratification of the delta, but lakeward there is but little unconformity because of the slowness of the building process, as nothing but the finest silt can reach the lake through the sluggish inlet. This also accounts for the slight rise away from the lake, all the coarser material having been deposited immediately upon reaching the flats.

Fall creek leaves its gorge and enters this delta, the material of its banks becoming finer and the current becoming slower as it approaches the lake, half a mile distant, till at the mouth nothing but the finest silt can be carried along by the feeble current.

On the beach, in the middle of the delta, is a deposit of pebbles, the origin of which is interesting. They could not have been carried down through either of the two streams across the flat. It is hardly possible that they were brought from the east side of the lake by littoral currents and wave action set up by the prevailing north winds, as, for a long distance in the corner of the lake the water is extremely shallow, and no such pebbles exist there. The water, opposite the deposit, is less than two feet deep for several hundred feet out, and similar pebbles are scattered over the sandy bottom; so it is probably that the shore ice and that coming down the creeks, with pebbles frozen in, has been blown aground in shallow water, where it has melted and dropped the pebbles and the latter have been washed ashore during storms.

Continuing up the valley, south of the delta, the land rises gently with a rolling aspect to the top of the terminal moraine at Spencer summit — a distance of 15 miles. Beyond the beginning of the

delta flat, the valley narrows considerably, but still is very wide in comparison with the small stream running through it.

Continuing southward, the valley slowly rises, the morainal hills constantly become more prominent, and are here and there intercepted by kettle-holes forming small lakes and swamps in the wet season.

A cross-section of the valley, where the moraine is typically developed, presents the following appearance: the valley is half a mile wide, or less, the highest hills on either side being rounded, drumlinoid hills cut out of the country rock, and by stream erosion, and as a general thing have almost no drift covering, as shown by their being uncultivated.

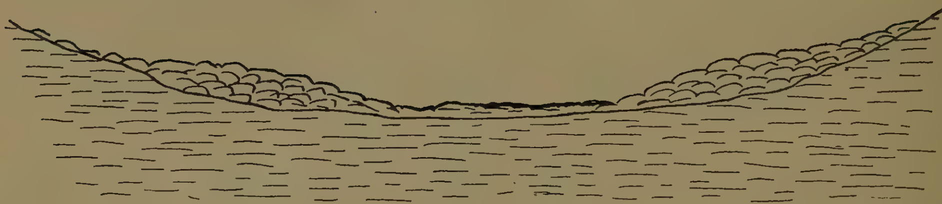
Just within these bounding hills, and perhaps a third their height, are the typical morainal knolls, most of which are of stratified material — at least in part. Near Newfield one of these hills consists of a fine quality of blue clay with but little iron stain, which is used for brick making. Much sand of excellent quality is visible where streams have cut into the banks.

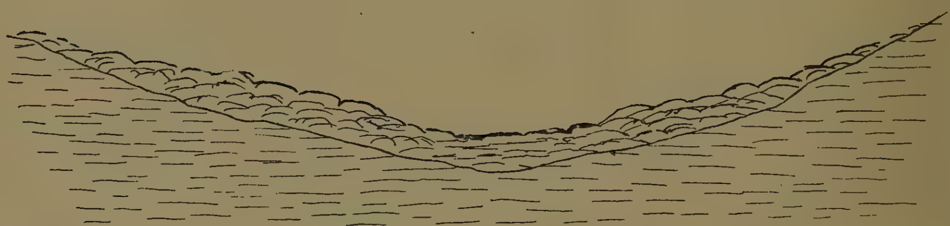
These irregular knolls grade down in size quite rapidly toward the center of the valley, which is flat for a considerable distance before the hills rise again on the opposite side.

Along here the "Inlet" is but a small brook, and it is an excellent example of an overladen stream. To suppose that it had cut down through the drift and so formed its broad, flat valley would be unwarranted. The amount of erosion through the drift-filled, preglacial valleys in the neighborhood, by streams of much greater volume and flowing more rapidly, has not been one third as great in any instance.

How, then, are we to account for this valley? It would require a great amount of study over the whole region to account with certainty for the position of the drift. A mere reconnaissance shows it to be a preglacial valley choked with drift. The drift is higher on the sides than in the center — this may be due to a greater depth of deposit along the sides, (Figure 2, a) or to a greater depth of original erosion in the center and a comparatively uniform deposition of drift, (Figure 2, b).

Fig. 2





Of course, to a certain extent, the latter cause must have had an influence, but I am inclined to believe that the drift in the center was never a great deal deeper than at present

There must have been a current of water under the final tongue of ice extending up the valley, and this would have tended (according to its strength) to keep the center more free from drift. As the ice tongue retreated down the valley this stream must have entered a lake bounded by the ice at one end and the moraine at the other. Thus a continuous delta would be formed and would tend to deepen the center deposit. But there are signs of a rapid retreat of the ice, so this delta may not have had time to completely level up the topography. It may exist to a greater or less extent; we have no means of knowing.

Again, there would be considerable lateral morainal material formed on the sides of the ice-tongue from the hills above, and on the melting of the ice, this would be deposited along the sides of the valley.

The top of the moraine is at Spencer summit where it forms the divide between Cayuga lake valley on the north and the valley of the Susquehanna river on the south, the walls of these two valleys being continuous.

Tracing the moraine over the hills on the east side of the valley it is found at Varna — just east of Ithaca and about 18 miles in latitude from its position at Spencer summit, thus proving the existence of the ice-tongue mentioned.

Six mile creek, which flows into the Inlet midway along the delta flat, is also in a preglacial valley. It was here that Foote thought the ice tongue divided.[a]

A study of the complete history of this stream would prove interesting. Its general course is north west, so the results of glaciation are very different from those seen in the main valley. At first it flows through a wide valley and is just beginning to cut into the country rock up above Brookton. Here it has cut through a large sand plain and formed an amphitheatre. Leaving this it enters a very narrow, winding gorge where it has cut into the side of the old valley; emerging from this, over a 40 foot fall, it is cutting through a drift and clay filled valley and suddenly enters a second narrows for the same reason as before; then after winding through another drift filled region, it flows through its old gorge from which, for a short distance, it has almost completely removed the drift and is cutting into the country rock along one side or the other; then it emerges upon the delta flat.

Two interesting features of this stream are: (1) that the terminal moraine crosses it several miles north of where it crosses the main valley, and is very much smaller here; (2) the presence of a small dyke of eruptive rock crossing the gorge just above the falls mentioned.[b]

All along the lake valley are numerous streams — the smaller being entirely post-glacial, but all of the larger creeks are either in preglacial beds, or are post-glacial at their mouths and preglacial above.

Salmon creek is a type of the latter. It enters the lake seven miles from its southern end on the east side. Its general direction is south and it is very similar in topographic features to Six mile creek—flowing in a very broad preglacial valley from its source to within a mile and a half of the lake, where it drops over a 40 foot fall and enters a ravine from which it has removed most of the

a See page 142.
b Green Tree falls.

drift, and is cutting into the country rock. It emerges from its ravine at the lake edge and has built out a small delta.

Taughannock creek, nearly opposite, is in the largest ravine in this section. It has a water fall of 215 feet and below the fall has a depth of nearly 400 feet. The upper part of this valley is preglacial, and as it enters the postglacial portion the stream turns sharply to the southeast for a short distance, then resumes its northeast course to the lake.

A few hundred yards to the north of, and parallel to the gorge, is a sharp depression in the topography, dying out as it nears the lake and beginning just below the bend in the stream.

Two tiny streams, dry except in wet weather, have cut this depression to the depth of 50 feet at one place and have not reached the rock, while the drift, covering all about here, is not more than 10 to 25 feet deep. This is distinctly the mouth of the preglacial stream of Taughannock creek, it having been turned off at the bend by drift.

At the mouths of all these larger creeks are a series of three or more terraces of stratified drift. They were evidently deposited in water by the streams after the drift had been laid down by the retreat of the ice.

Mr R. F. Livingston, of Cornell university, has presented a paper on their origin.

The next stream of importance here is Payne's creek, about a mile south of Aurora. It enters the lake flowing a little west of north. It is in a distinctly preglacial valley. As the stream leaves the ravine, it enters a flat area terminated southward by the drift covered rocks rising gently to a considerable height, and extending northward several hundred yards, where it is crossed by a smaller stream flowing in a southwest direction. It is bounded on the north by the ground rising much more gently than it does at the south.

Beginning at this gorge and running northward about 70 feet above the lake is a terrace of differential disintegration, a level break in the general upward slope of the land, which fades out as the shore cliff rises two miles away. On this area the drift is much thinner than below it, but, as it is cut into by a stream at only one place, it could not be satisfactorily investigated.

Continuing up Payne's creek attention is drawn to the width of the valley and to the flat bottom, completely covered by a strati-

fied deposit of gravel and sand. Along some exposures the strata exhibit the lenticular arrangement common to any stream bed — coarse pebble beds grading into finer — and these in turn ending in a sand deposit, but near the mouth there is a solid layer of loam with a few pebbles in it.

The ravine maintains this same appearance of a broad valley with a stratified bed, for something over a mile, when it is suddenly terminated by a horseshoe shaped ledge about 300 feet wide, over one corner of which the stream falls. Prof. Freley, of Wells college, stated that the bottom of this fall is about 45 feet above the lake level.

The south wall is country rock all the way to the fall, and on top of it can be found the series of terraces, though they are not well marked, as the slope is more gentle here than along the streams to the south.

On the north side the numerous runlets enter the gorge more gradually than on the south side, and show the rock to be at some distance from the bank of the gorge and the intervening space to be filled with drift.

Passing over the rock hill which forms the shore cliff, a mile north of Aurora, the country rock has been worn away to a much greater extent and the drift is somewhat deeper, giving a more rolling aspect to the topography. The Helderberg limestone is the country rock here and several quarries in it show excellent sections through the drift and striations on the top of the rock bearing North 8° West as may be observed in the quarries in Taughannock ravine on top of the Tully limestone just across the lake, and in many places about Ithaca.

At Union Springs, the rock hill which forms the lake boundary thus far, begins to recede, and from here to the outlet of the lake, the shore is much flatter. Marshes and inlets abound along the shore — a feature entirely absent above except on the deltas at the mouths of streams. For the remainder of the distance the shore is composed entirely of loose material — glacial drift which slopes gradually up from the water to a height not exceeding 200 feet and averaging much less.

The lake is much shallower from here to its outlet, running from 30 feet at Union springs to 10 or 12 feet at the end.

At Cayuga, about one mile from the outlet, the shores are much lower and more muddy, the highest ground for some distance from the lake being about 100 feet.

Eastward from Cayuga are a series of glacial hills typical of this region. They are well illustrated by two ridges which the road cuts through.

These are about 400 feet apart; they bear about North 8° West and are, so far as can be observed, entirely unstratified. They consist of glacial material, scratched boulders, gravel and clay, all mixed confusedly together and showing signs of having been pressed together. They are each about a quarter of a mile in length, the northern ends are very steep, while the southern extremity gradually fades away. The bases are 200 feet wide, and the smoothly rounded sides rise steeply to a height of 50 feet.

Looking in any direction from the top of one of these ridges, the whole country is seen to be covered with the same type of hills of various sizes. To the south and southeast about four miles, rises the rock ridge which forms the wall of the lake from Union Springs southward. These drumlinoid hills stretch clear to its foot.

As to their origin, they present all the features of drumlins except that the longer axis is greatly exaggerated, and their history is probably much the same. Perhaps for some reason the ice had a more rapid motion here and the drumlins were drawn out. Or, a more rapid melting of the ice, (and there are several reasons for believing that it melted very rapidly in this valley), might account for their great length.

Over on the west shore, the same features are seen. The rock hills are farther back and the ground between them and the lake is covered with drumlins.

Northward from the end of the lake, stretch the Montezuma marshes.

These constitute a low flat area, filling the valley and widening northward for seven miles to Montezuma — then stretching off to the north and east. Through them flows the Seneca river which drains Seneca and Cayuga lakes and empties into the Oswego. The surface is a thick peaty mat beneath which is a layer of impure marl of varying thickness. The underlying rock belongs to the Salina group and numerous salt and iron springs reach the surface. The

marshes are terminated on each side by the country gradually rising in the peculiar elongated drumlins seen at Cayuga. More typical drumlins are loosely scattered over the marsh, being particularly well developed at Montezuma.

In the region of the drumlins, water courses are extremely rare—even tiny runlets are scarce except after heavy rains. The whole drainage is subterranean, thus accounting for the numerous springs in the marsh below.

Fig. 3
Plan of Cayuga valley.

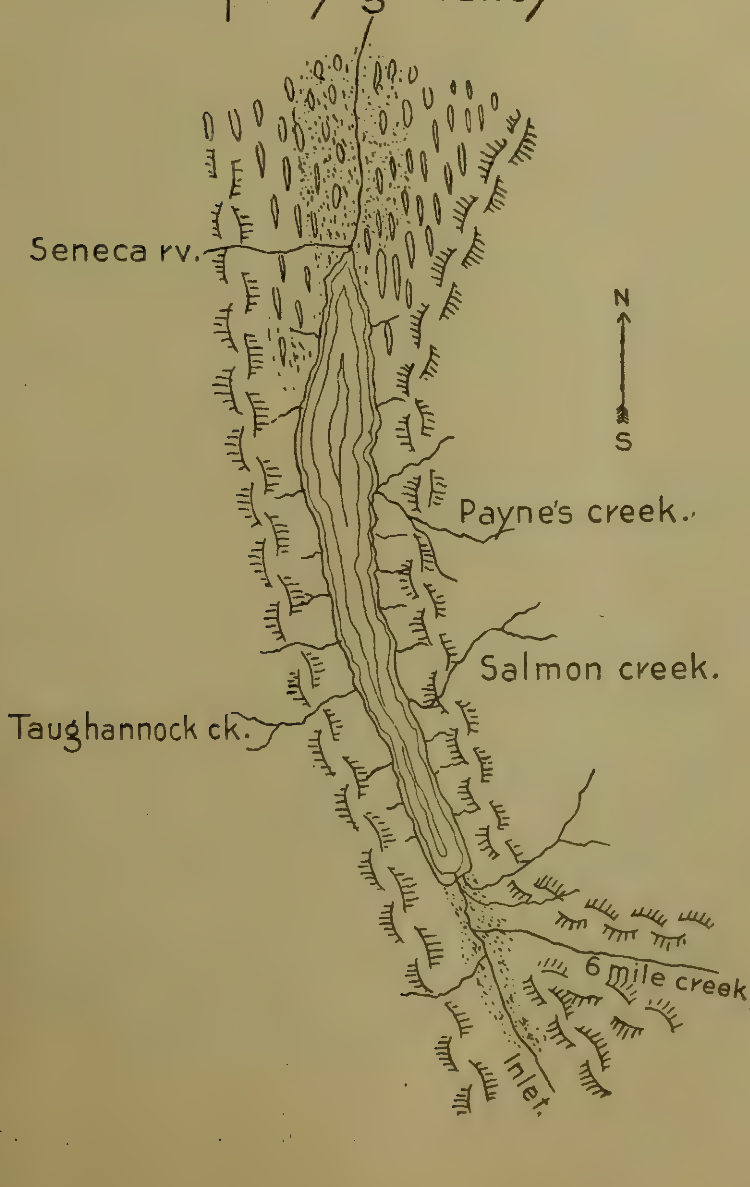


Fig. 3 shows the general features of the region. It is not drawn to scale, but shows the relation, form and position of the main valley and Six Mile creek valley at the south; the form of the lake, the rock hills retreating at the north end and the marsh lined with drumlins.

The rock of this region is Devonian, that on top of the high hills south of the lake belonging to the Chemung group, while that northward belongs to various divisions of the Hamilton.

The general trend of the strata is to rise northward at an angle of about two degrees, thus exposing along the lake the Ithaca shale, Genesee shale, Tully limestone, Hamilton shale (sub-division), Marcellus shale, Helderberg limestone, and the Salina group underlying the northern end.

Tracing the Tully limestone along the lake it is noticed that it rises above the lake level three miles from the southern end. It forms an anticline six miles long, reaching the lake surface again just below Taughannock, and having a maximum height of 150 feet. Then it follows the shore for several miles and gradually recedes from the lake in the form of a terrace, and disappears beneath the drift.

Jointing is well illustrated in all the rocks, and fossils are common in many of the strata. In the Marcellus shale are numerous concretions. The smaller of these are usually centered about nodules of iron pyrite, and the larger ones — many of which exceed two feet in diameter — have cracked and the crevices are filled with calcite.

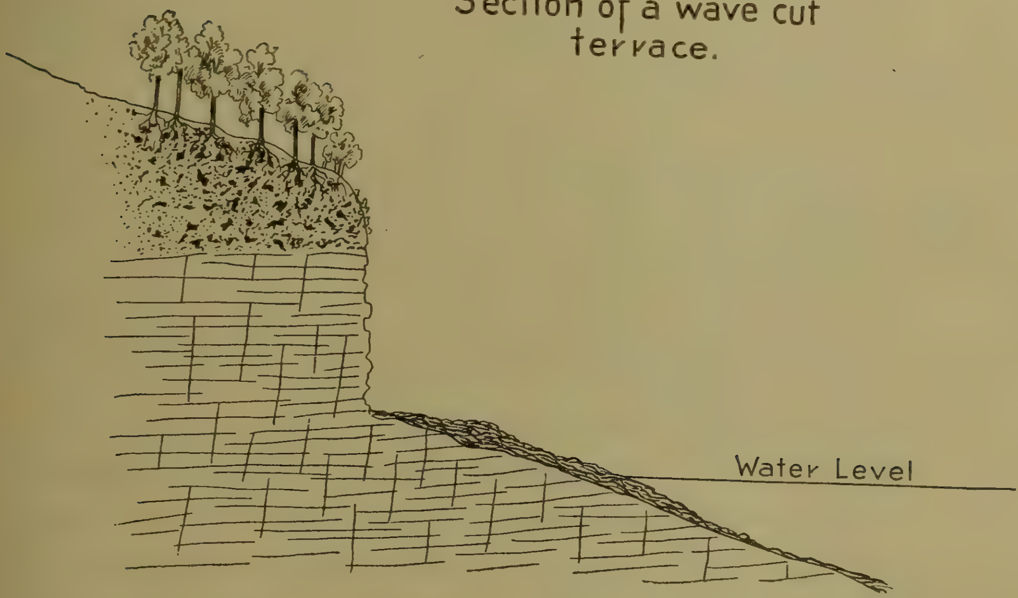
Where the shale forms the shore line, the wave-formed terrace is admirably developed, the soft rock weathering so rapidly that the wall remains perpendicular. But wave action on this narrow lake is incompetent to account entirely for the high rock bluffs which may exist. The prevailing winds are a little west of north, yet the cliffs are as prominent on the west side as on the east. When the lake was formed, there must have existed a very steep slope, if not an actual bluff, where the cliffs now are, which shore action, greatly aided by frost, has cut back into the typical wave-cut terrace.

How such a bluff might be formed will be discussed later.

The sketch of a cross section of such a cliff shows these features: The drift covered rock with a perpendicular front and a gradual slope beneath the water covered with material from the shore, and the shingle-strewn beach protecting the base of the cliff. See fig. 4.

Fig. 4

Section of a wave cut terrace.



At several points the cliff is interrupted by banks of drift. On examining such a bank it is noticed that the rock ends and the gravel begins abruptly. The small runlets coming into the lake over such an area of drift may have cut down to considerable depth, but they do not reach the bed rock. The gravel itself is entirely without stratification, and the pebbles striated and of a heterogeneous character. It is evident that these are preglacial stream courses, completely choked by drift. An excellent example is seen about mid-way between Ludlowville and the south end of the lake.

So much for the geology and topography of this region. Let us now investigate the historical side of the problem.

What is the origin of Cayuga lake?

There have been many answers. An excellent list of brief quotations from many writers has recently been given by Prof. R. S. Tarr in an article on this subject.[a]

The earliest report upon this district is from Vanuxem, in which he notes that the accordance of the strata on the opposing cliffs precludes faulting to account for the lake basin, and that to consider the theory of the subsidence of the bottom is absurd. He notices the rounded foreign pebbles along the shore, and, as they are of northern rock, he concludes that the excavation was accomplished by a south flowing stream previous to the strata being tilted.

His words are —[b] "The lakes to the south of the Helderberg range are an important and interesting feature of the district, furnishing facts to show that the excavation of those at the west end of the district (Cayuga, etc.) was anterior to the dip of the rocks, etc. * * * The whole of these differ in no respect from the long parallel north and south valleys of the same section, but in depth of water and apparently greater depth of excavation."

The veteran geologist Dr Hall, while not able to give the explanation at that time, was distinctly on the right track when he wrote —[c] "The valleys of Seneca, Cayuga and Crooked lakes, Canandaigua lake and others, are of nearly equal width from one extremity to the other, with nearly perpendicular banks above the water. It seems hardly possible that such channels could be excavated by the advancing and retiring waves upon a coast which was gradually emerging from beneath the ocean." And again— 'They (the lakes) are all situated in valleys of erosion; the rocky, strata, with a slight dip to the south, appearing on both sides."

Much later, and after the glacial theory had been established, Simonds mentions the two kinds of valleys in this region, viz., gorges, or "true valleys of erosion," and the broad, flatter type. Being unable to account for the latter by stream erosion, he concluded that "these deep, well-worn valleys are undoubtedly the result of glacial action."

According to this hypothesis the glacier had to divide at Ithaca — one part continuing up the main valley southward — the other part

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a Cayuga lake a rock basin. Bull. geol. soc. of Am.—Vol 5. pl. 14—1894

b Geol. of New York—3rd district, Vol. 3. 1842 p. 237

c Geol. of New York. 4th district Vol. 4. 1843 p. 321

moving off nearly at right angles and carving out the valley of Six Mile creek. He says of these valleys:

[a] "Noting in addition (to their even slope) the depth at which the water flows and the small number of cascades and waterfalls, the conclusion is at once reached that these valleys have been acted upon by some agency not now in operation."

Foote writes in about the same line, and he believes that icebergs played an important part here. Both he and Simonds neglected to notice that these "broad valleys" are found in this region running in almost every direction, and therefore that the glacier could not possibly account for them.

Still later, Spencer arrives at a different conclusion. He writes — [b] "Though the bottoms of these lakes are frequently below the sea level, yet in no case, that I am aware of, are they nearly as deep as Lake Ontario. Doubtless these small lakes were former expansions of the rivers running into Lake Ontario in preglacial times, and owe to ice, simply, the closing of their outlets by drift."

Prof. Davis' opinion was, (referring to Cayuga lake) — [c] "Its trough was cut by an old stream flowing from the New York and Pennsylvania plateau, northward into Lake Ontario, at a time when the drainage of the region ran in channels considerably below present river levels; glacial erosion has probably smoothed and deepened it, but to suppose it entirely so formed would imply the production of a tongue of ice from the front of the old glacier, peculiar in form and remarkable in erosive power; the supposition that it is the result of down faulting or local subsidence, is negatived by the absence of disturbance in the neighboring hills; to call it a rock basin is entirely unwarranted, for its prolongation north of the lake is across a great drift area, without rock in place. The form of the trough is different in no important particular from valleys of evident erosion in non-glaciated regions."

The next is Johnson's opinion, in which he says—

[d] "That these lake basins were excavated by glacial action, seems almost self-evident, and is, indeed, almost universally admitted.

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a Am. nat., Vol. 11, 1877, p. 49-51

b Proc. Am. phil. soc. Vol. 19, 1881, p. 333

c Proc. Boston soc. nat. hist. Vol. 21, 1882, p. 359

d An. N. Y. acad. sci. Vol. 2., 1882, p. 260

Their radiated arrangement, in my opinion, admits of but one explanation, namely, that they were cut by one and the same glacier, whose margin was broken into several streams in crossing the mountain ridge."

Chamberlin, a leader of the modern school of glacial geologists, holds the same view. He writes:

[a] "That these troughs were the preglacial channels of streams does not seem to me to admit of reasonable doubt; but that there was a selection and moulding of glacial corrasion seems equally clear, those channels that lay in the direction that would have been pursued had the ice moved on a uniform floor, being ground out wider, deeper, straighter and smoother, while those in a transverse direction were measurably filled and obscured. The whole region shows, in a most beautiful manner, the subduing, softening effects of glacial grinding and deposition, without the obliteration of the bolder features of the preglacial configuration."

Wright rather inclines to the opposite view, agreeing with Spencer and Upham, when they use the fact that the bottoms of these lakes are below sea level as evidence of a preglacial elevation and post-glacial depression of the district.

Wright says [b] "The ice movement naturally centered itself more or less in these north and south valleys, and hence somewhat enlarged them, but probably did not deepen them. The ice, however, did prevent them from becoming filled with sediment, and, on its final retreat, gave place to water."

[c] Ramsay writes that the basins are not entirely ice worn, as is proved by the presence of the large number of preglacial tributaries flowing in all directions. It is not strange that this, taken in connection with the general form of the lake valleys and their resemblance to mature valleys outside of the glacial belt, should have led those who have taken a cursory glance at the region to conclude that the lakes are merely drift-dammed rivers; particularly as the general opinion has, of late years, been turning away from the belief in glacial rock basin erosion, since so few instances of this work have been definitely proven, though the theory has been before us for 30 years.

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a U. S. geol. sur. 3rd an. rep. 1883, p. 358

b "Man and the glacial period" 1892 p. 94 and "Ice age in N. A." p. 323

c Quart. jour. geol. soc. Vol. 18. 1892 p. 185

FIG. 5.

To face p. 145.

E. D. Evans, photo.

VIEW OF CAYUGA LAKE AND THE ITHACA DELTA FLAT FROM SOUTH HILL.

Dr Lincoln and Prof. Tarr, writing entirely independently but nearly contemporaneously, arrive at the same conclusion as this paper — their strong point being taken from the series of preglacial streams entering the valley at nearly the present water level.

Prof. Tarr says — [a] "Cayuga valley is a preglacial valley enlarged by erosion. Being preglacial, it shares with the other similar valleys of this plateau the mature form or habit. A mature valley has a more accentuated topography near its head than near its mouth. In the latter portion it is broad, the valley sides are low, and the tributaries enter through valleys which, near their mouths, are shallow. As the head waters are approached the valley walls become steeper, nearer together, and the tributaries enter through deeper and narrower valleys than those near the mouth."

We have seen that the valley, in which lies Lake Cayuga, is 60 miles long; and that, if the terminal moraine at Spencer summit was removed, it would continue clear down into Pennsylvania; and that it is distinctly preglacial.

We have noticed the similar valley of Six Mile creek entering it at an angle of 45°. Between these rises "South hill," and a photograph taken from this hill shows the character of the lake valley. (Figure 5.)

The main valley is on the right side of the picture, and Six Mile creek flows between the site of camera and the city, at the foot of the hill.

It has been observed that on proceeding down the lake the enclosing hills gradually lessen in height, become less steep, and finally recede entirely from the lake shores.

Another feature of the several streams previously described should be noticed. The mouth of the gorge of Six Mile creek, as Prof. Tarr [a] points out, is distinctly rock enclosed, and the stream is now flowing in the same valley as the preglacial stream did. It enters the delta flat at an elevation of about 30 feet above the lake.

The drift buried pre-glacial valley on the east shore, midway between Ithaca and Ludlowville, is cut down to within a foot or two of the lake level.

Salmon creek is also rock enclosed.

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[a] Bull. geol. soc. Am. 1894. v. 5. pl. 14

As Prof. Tarr says: — [a] "On the lake shore and in the side gorges, the shale can be traced in outcrops with practical continuity to the mouth of this valley on either side, so that the preglacial continuation of the valley is not buried beneath drift in the present hillside. There is no gap in the series of outcrops with a width of more than 200 yards."

The rock bottom of Salmon creek can be traced very nearly to the lake level. It may be cut down a little, but only a little, lower than the lake level and covered with the delta material.

The evidence at Payne's creek, near Aurora, is still more striking. The lower part of the stream bed is entirely of loose material— no rock being visible for a long distance up the creek — showing that the preglacial stream cut its valley below the present surface of the lake. Just how far down the rock bottom is, can not be accurately known. There is an old sulphur spring just here, drilled, I am told, by a Syracuse firm, but nobody seems to know where the driller's notes are If they could be found they would decide this point.

The preglacial rock wall of this stream rises 100 yards south at a gentle slope. Knowing the general form of such valleys in this region, we can draw a profile to scale, and by the curve of this slope we can get a rough estimate of the depth of the bottom of the preglacial valley below the lake level. By this method I conclude that the rock bottom of this stream is at least 45 feet below the lake surface and not more than 65 feet. (These are the two extreme estimates.) Of course this method is rough, but a glance at the ravine and its surroundings is convincing that the rock bottom is a number of feet below the present stream bed at its mouth.

We have noticed that the hills enclosing the lake valley diverge gradually northward — from being half a mile apart at Spencer summit to some eight or 10 miles at Cayuga — a distance of 60 miles; that these hills also decrease in height northward; we have found three preglacial valleys whose bottoms become lower, respectively, toward the north. The only logical conclusion therefore, is that the lake lives in the valley of a preglacial stream. Fig. 6 will illustrate this evidence.

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a Bull. geol. soc. Am. 1894. v. 5, Pl. 14

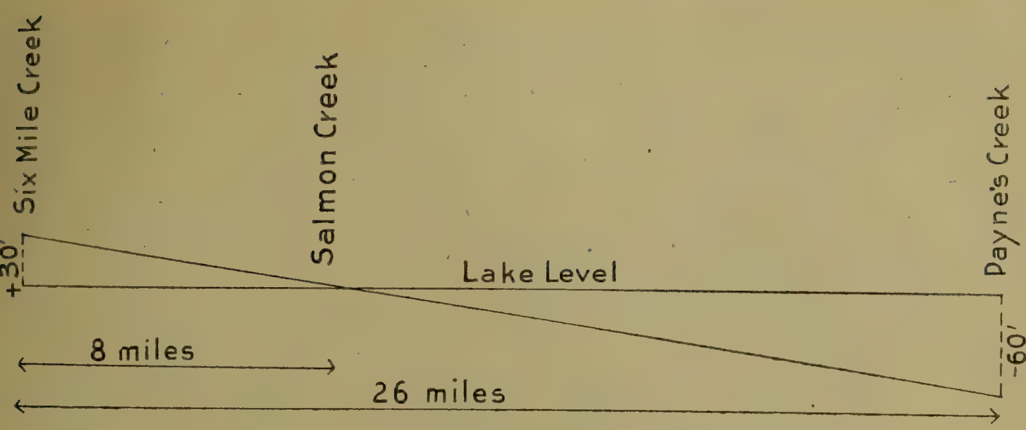

Fig. 6

Laying off vertically the 30 feet elevation of Six Mile creek and the 60 feet depression of the mouth of Payne's creek, a horizontal line representing the lake level, 26 miles long (the distance between these two creeks) and connecting the points so determined by a straight line to represent the slope of the preglacial main valley, which may well be considered a uniform grade along this part of its course — we find that this line cuts the lake level eight miles from Six Mile creek — just the distance between that point and Salmon creek, the mouth of which we found to be so nearly on the lake level.

That this stream flowed northward is equally obvious.

At what elevation compared to the present lake surface did this stream flow?

I think it is safe to say that the three tributaries studied had reached the same state of maturity — if they had not actually established the profile of equilibrium near their mouths.

If the bottom of the preglacial Payne's creek is 55 or 60 feet below the surface of the lake at its edge, and if the foot of the first falls is 45 feet above the lake, then the total fall of the preglacial stream in this distance of about a mile was about 100 feet. The possibility of the stream being locally diverted from its old channel at the falls is very remote, for the high rock walls on both sides of the stream above the falls preclude this view.

If the lake were drained, so that only a stream occupied its present bed, this stream would flow 1¾ miles from the creek's present mouth, and nearly 300 feet below it. If this were the original con-

dition, we would have a mature stream, in a region of remarkable homogeneity of structure, suddenly dropping off near its mouth at a much steeper grade than that a little farther up — a condition contrary to the definition of a mature stream. Therefore it is evident that at the lake shore the preglacial valley of Payne's creek must be filled to a depth of at least 50 feet.

Considering Salmon creek in the same way, we have a still more remarkable case.

The stream for a mile and a half above its mouth descends no more rapidly than Payne's creek,— that is, 100 feet to the mile.

The distance from its mouth to the center of the lake is $\frac{3}{4}$ of a mile, while the depth of the lake here is about 350 feet. So that, if the main preglacial stream flowed on the bottom of the lake, the old creek would have fallen 350 feet in $\frac{3}{4}$ of a mile at its mouth and then suddenly have changed its slope to but 100 feet in a mile. Surely such a condition could never have existed in a mature stream, as this unquestionably was.

If, as I have claimed, these two streams had established anything like the profile of equilibrium for two or three miles near their mouths, with the slope at the rate of 100 feet to the mile, (which is many times greater than the usual rate of fall of a mature stream) then the preglacial main stream (considering it to have been near the center of the lake) must have been about 150 feet above the lake bottom opposite Payne's creek, and more than 250 feet above it opposite Salmon creek.

Similar evidence can be deduced from several other preglacial streams and from buried valleys along the shores. But the two given are typical, and the evidence of the others is not needed.

Of course these figures are deduced from the few actual measurements it is possible to make, and do not pretend to be exact. They are introduced, because they follow logically from the conditions that would exist if the conclusion reached (that the preglacial stream flowed above the present bottom of the lake) were true, and the fact that the estimates do fit the hypothesis so well is a strong argument in its favor.

As to what caused the deepening of the valley—a careful study convinces me that there can be but one answer—ice.

To claim for ice the power to pass up a stream valley and erode it to the depth of 250 feet (as off Salmon creek) may seem to call

for a very great erosive power. So it does, but it can be demonstrated that it is possible. In the first place the rock here is soft shale, with some sandstone and a few strata of limestone.

It is extremely brittle, and is intersected every yard or so by well-defined joint planes which render it still more easily broken. It would be very susceptible to water percolating into the cracks and freezing beneath the ice, and so loosening it still more.

Secondly, a depth of 250 feet is not excessive, compared to the width of the valley.

Figs. 7 and 8 are drawn to the same horizontal and vertical scale to show the proportion. Fig. 7 is the cross section through one of the narrowest parts of the lake, and the proportion is therefore a maximum. Fig. 8 is through the deepest part of the lake.

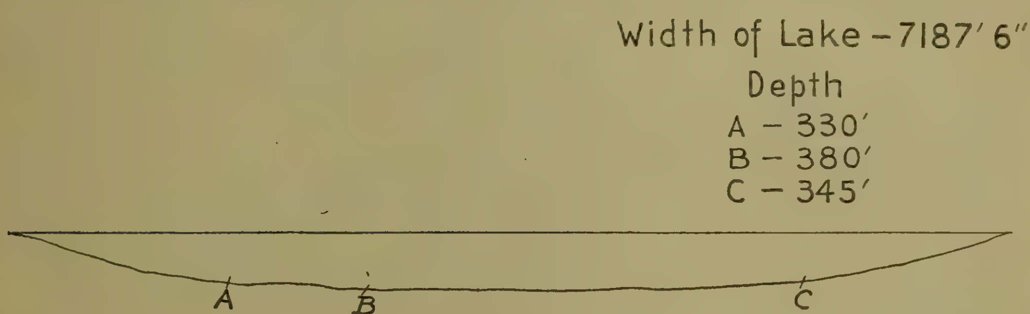

Fig. 7

Section at Willow Creek, drawn to scale.

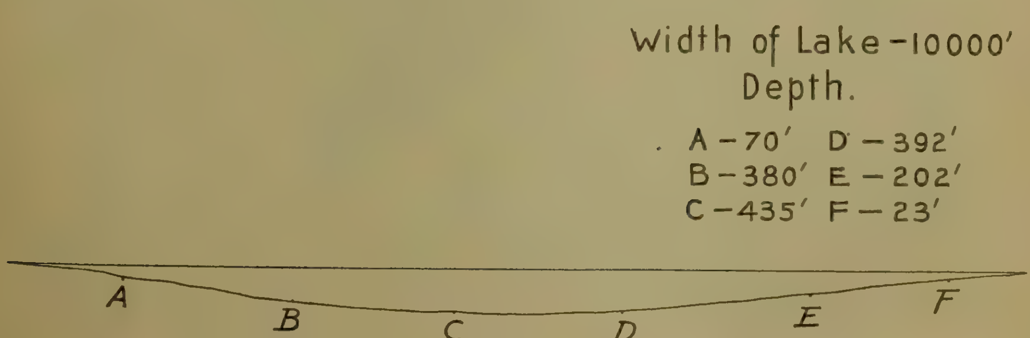

Fig. 8

Section at Atwaters, drawn to scale.

Thirdly, there is every evidence of the existence, (probably during the latter part of the glacial epoch) of an ice tongue extending up the valley. It would be reduced by melting, but the hills would concentrate it in the valley, and the erosive power in the center would thus be increased. Naturally a small projection like this from the front of the ice sheet would fluctuate greatly, thus also increasing the erosive power by giving an alternating motion.

There are considered to be a few proofs that this action has taken place.

A fair sized pebble of the Tully limestone can be recognized by any one familiar with the Tully strata along the lake. Immense boulders of it are found strewn over the high hills south of the lake, often 10 miles from the beginning of the outcrop along the lake, and several hundred feet above it. They can be accounted for only by ice transportation, and the lake valley is the only place they can have come from, as there are no outcrops of it elsewhere in the neighborhood.

Glacial striae are found at almost any point along the slop of the valley, beneath the drift, and as a general thing they run in several directions, showing the fluctuations already ascribed to the ice tongue. Fig. 9 is taken exactly from a slab of shale from the north side of Taughannock ravine.

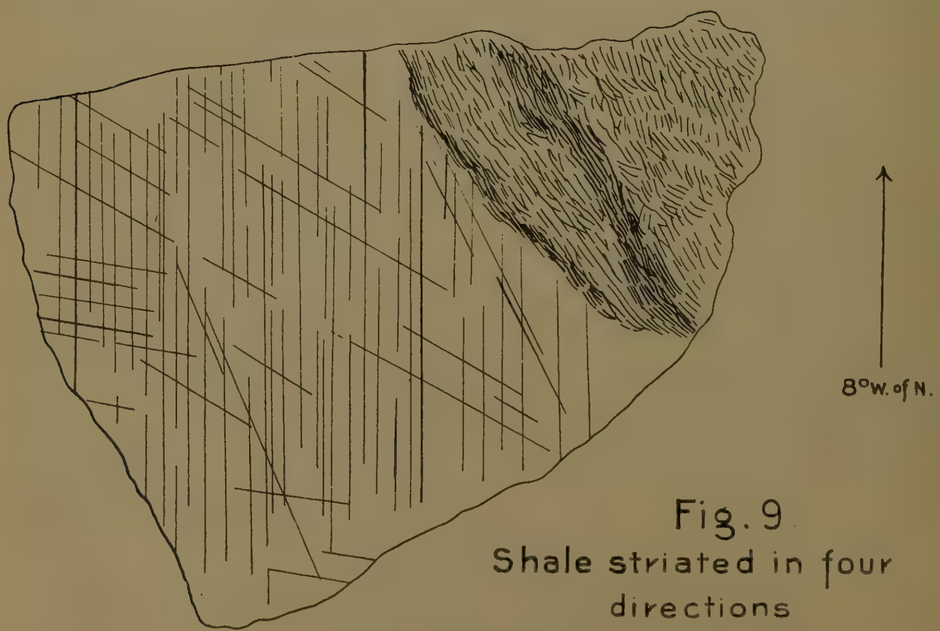

Fig. 9
Shale striated in four directions

It shows the predominant north and south markings, and three other series pointing at various angles down the valley slope.

Along the road on the east side is a vertical face of rock showing the striae at several angles of depression, this evidence being much more convincing.

The very form of the lake is a strong evidence of the force that made it. Along the lower half, which is north and south, the width averages a mile greater than that of the upper end, which bears northwest, and narrows just at the point where it changes its direction.

This is just what we notice in the tributary preglacial valleys—that those running north and south are much wider than those extending in other directions — and this feature is unhesitatingly ascribed to glacial action. Certainly then the same force could perform a greater work in a greater valley.

That a drift dam is an important feature in Cayuga lake is certain. The gradual shallowing at the lower end, the drift covered shores, and the topography of the surrounding country, all bear witness to this.

We have at present, no exact knowledge of the depth of the drift dam. At Seneca lake, it is from 150 to 250 feet or more, and very likely this is equally true at Cayuga.

The origin of Cayuga lake, as I have translated the evidence, is, that an extremely old preglacial valley has been cut much deeper and wider and converted into a rock basin by the erosive power of ice during the glacial epoch, and the depth of the basin thus formed has been increased by a drift dam.

The other theories to account for such a basin as this are :

1 Solution of material and settling of the bottom.

Whatever may be the value of this theory in other regions, it can not be applied here, as there is no soluble rock in this region except a little in the Onondaga salt group, and that is north of the lake. Were this true, the strata somewhere along the sides must show the bending—but they do not.

2 Faulting.

This is out of the question, as not the slightest trace of it can be found anywhere in this region.

3 Water erosion.

This theory is impossible, for a great part of the lake bottom is below the sea level. If it had taken place to any such extent at a time when the land was elevated the valley ought to be wider, and the shores certainly would not show perpendicular cliffs.

4 Secular disintegration and removal of material.

The homogeneity of the region is too complete to allow of such an action to such an extent.

5 Moulins.

This formation certainly can not be applied to this lake.

I can, therefore, see no other explanation possible than that given above for the origin of this lake.

A change of the continental slope might possibly lead to a misinterpretation of the old stream phenomena—but it could in no way affect the results of glaciation so far as they have been used as an argument here.

The formation of this lake is certainly an argument in favor of the theory of extensive ice erosion in solid rock.

Appendix

Fig. 10 shows the last fall in the gorge of Fall creek, Ithaca, at the mouth. Comparing it with Fig. 5 shows the difference between the post glacial and preglacial valleys in the local rock.

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FIG. 10.

To face p. 152.

E. D. Evans, photo.

ITHACA FALLS, FALL CREEK GORGE, AT ITHACA, SHOWING THE POST-GLACIAL STREAM BED.

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University of the State of New York

BULLETIN

OF THE

New York State Museum

VOL. 4 No. 18

NOVEMBER 1897

POLISHED STONE ARTICLES

USED BY THE

NEW YORK ABORIGINES

BEFORE AND DURING EUROPEAN OCCUPATION

PREPARED BY

WILLIAM M. BEAUCHAMP, S. T. D.

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1897

CONTENTS

INTRODUCTION

The preliminary paper on our aboriginal articles of stone comprised those which were simply chipped, and these are much more abundant and widespread than those treated of in this bulletin. The latter, however, show almost incredible patience and skill in their higher forms, as well as taste in selecting materials. They also give hints of superstitions and ceremonies not yet thoroughly understood, and therefore not now discussed. As before, this paper has been prepared and illustrated by the Rev. W. M. Beauchamp, S. T. D., the figures being from his large collection of original drawings, made in nearly all parts of New York, but mostly from the central portion. It is probable that the southwestern counties might add a few forms, as that region included a portion of the mound builders' country, and was a border land. A few illustrations might have been added from other writers, but neither these figures nor the descriptions were deemed accurate enough for the present purpose. Those given have been carefully prepared, and every detail has been represented wherever opportunity was afforded.

POLISHED STONE IMPLEMENTS OF THE STATE OF NEW YORK

In considering polished stone articles as a class, it is necessary to divide some departments, as pipes, ornaments, and vessels of various kinds, much alike in form and use, but not in material. The modes of manufacturing these, however, are sometimes so different that no farther excuse need be made. Clay and stone specially mark eras in human progress.

Under this head will also be included picked implements, for picking was commonly part of the process of forming polished articles, which are found in all stages of development. The picked implement was rarely finished. Sometimes grinding was the first act of all, but not in general. A few stones, naturally formed for use, might receive an edge at once. More commonly they were chipped, picked and polished as time or needs permitted. This is most frequently seen in the case of celts and gouges, where the same site may yield every gradation, from the rudest to the finest, and sometimes unite every process in one implement.

The number of unfinished articles of a high grade is quite suggestive, many of these being found on small camps, not indicative of long continued residence. Among others, tubes, banner stones and pipes were thus carried about, to be completed in the leisure moments of camp life. Many of the finer finished articles were also carried on journeys, indicating some possible use away from home, more superstitious or common place than ceremonial. Some features of this distribution will appear in considering these. The locality in which others were found will point out modes of travel, and perhaps indicate whence the travelers came.

Some of the best results of New York work, however, will be in determining the age of many articles hitherto undated, and in sometimes assigning them to their true makers. Much progress has already been made in this comparative study, and a thorough exploration of a few well known sites would give valuable results. Several kinds of stone pipes were made only within the historic period, and the red pipe stone of the West first appeared in New

York but little over 200 years ago. Articles of shell have also been sadly misunderstood.

As to material, there are also valuable suggestions in some of these articles of polished stone. The aborigines had taste in selection when they required ornaments, and the Huronian or striped slate frequently appears, a few celts even being made of this. This indicates commerce, for it came from places farther north and west. Travel and traffic existed then as now. Gorgets are usually of fine stone, and are rarely unfinished. As a rule, they were brought here in perfection. For celts, however, any pebble might answer, and many are of ordinary field stones, always accessible to the common people. The abundance of basalt celts, even on recent sites shows a choice in material, and some of the green stones are beautiful indeed. Pestles are often well worked, but yet oftener are slightly adapted pebbles. Some are of great size. Hammer stones survived almost every thing else, but stone balls, used in war clubs by their fathers, are preserved by New York Indians yet. Such features will be more fully seen as we proceed.

When the white man came to New York, the Mahikans and other kindred nations occupied the Hudson River and the seacoast. West of these was the territory of the Iroquois, Andastes and Eries, also of one family. At that period the Iroquois at least used but little stone, nor are the finer early articles found on their earlier sites. As a rule, their pipes were of clay, ingeniously ornamented, and whether they had ever used or made others may be a question. Obtaining suitable tools from the white man, they afterwards made pipes of stone, in a sense going back to the stone age. The delicate drilling of the pipe stone, so often seen, was unattainable with aboriginal tools, and this is true of the small shell beads. Pipes and ornaments were articles of common use, however, and some nations were celebrated for their work of this kind, but we need never forget that most of their finery came from frailer materials. Within the historic period it is probable that many of the New York stone pipes were made by the Cherokees, as in earlier colonial times they were made in New England. Many stone implements, common elsewhere, are notably absent here, showing that some large nations

never penetrated this State. This is the case with the grooved axes and chungke stones. On the other hand the makers of some slate knives, amulets, and other articles here, never penetrated the South. So to speak, there was an aboriginal Mason and Dixon's line.

That many articles required a long time to finish, seems plain, and yet this time may have been overestimated, as in the early ideas of arrow making and other primitive arts. A dexterous workman went on confidently, and his simple tools were sometimes far more efficient than we think. Skill was more than instruments. Sometimes the stone was wrought while fresh and soft, hardening afterwards by exposure and use, as in the case of the Cherokee pipes; but a good flint or gritty stone cut many materials with great rapidity and ease. The fine finish may have been much slower work, reserved for a master hand. Drilling was done in various ways and most gorgets seem to have been perforated with flint. Banner stones were sometimes partially drilled with this, as appears in some unfinished pieces. Sometimes a tubular drill was used, as we find in the same way; sometimes a gouging process was employed. Precisely how the picking was done may be less plain, but effective hard and sharp stones are not rare. Usually it is very neat and uniform even where the material is hard. As polishing was the last process it began with the most essential parts of the implements as the cutting edge, where it often preceded the picking.

That many early implements of polished stone were not used by the later Indians, and indeed were unknown to them, is now well understood. This, like the same fact in chipped stone, points to a great and probably sudden change. They were not perpetuated by descent, nor acquired by conquest, but were simply lost arts, because there were intervals between the early and later comers. The stone gorget, banner stone, amulet, tube, boat stone, slate knife, grooved axe and gouge, had no place at all among the Iroquois, historic or prehistoric, yet all these occur more or less in their ancient territory. These, too, were among the finest of American articles of polished stone, and yet were utterly unknown to them, as far as appears. Thus, whoever was here before their coming had little in common with them, except in the very simplest

things. This difference is so great of itself as almost to prove them a different race, and this appears in other ways. In a broad way the Algonquin family might be included in this view.

Occasionally location has importance in considering probable use. Two grooved boulders in position may materially affect our opinion of their use and origin. The abundance of stone plummets in certain places indicates a local and special purpose. Two forms of polished slate knives may have great ethnological importance, and the almost utter absence of other things points out early differences otherwise unknown. More light still may result from farther research and clearer judgment, specially as comparative study goes on.

There is now little reason to doubt that the use of polished stone in America is nearly or quite as old as that of chipped articles, specimens of the former occurring geologically as early as the latter, if the tales of scientists are true. Indeed the idea of sharpening by rubbing or grinding would be quite as primitive and natural as any other, and it would soon be a question of the best use of material. Stones with a good cleavage would be chipped; those of a different character, ground. Bone or horn are often so well adapted for use naturally or by accident, that the slight grinding required would be at once suggested. Divesting ourselves of all prejudice, it would seem that the two arts would go hand in hand, as was certainly the case in New York. In this State the older polished stone articles are not only the finest, but are often far older than those of flint.

There was a period of decadence in polished stone work in New York before the coming of the white man. Shell, bone and horn had taken the place of some things, and clay of others. The stone pipe had largely disappeared and the polished stone axe or celt was almost the only fine article surviving in pristine beauty. These were soon to pass away, but steel tools occasioned a revival of ornamental stone work. Pipes of this material were made again; pipestone came east through the wars of the Iroquois, and was delicately wrought and drilled in great quantities, often by the white man's taste and skill; always with his tools. Small shell beads were made and distributed in prodigious numbers through the same means, but the flint arrow and stone axe utterly disappeared. The

return to the stone age, such as it was, came through the white man and not through the red.

It often happens that a number of stone articles can be assigned to one maker, as certainly as we can tell who made an old violin, although we know not his name. Things hundreds of miles apart will be found of some peculiar material and form, which can hardly be accidental. They will not be many in number, but they will have individual character. We recall many such. The skilful aboriginal artificer was as highly honored as any among civilized men, and his work had a wide reputation. In other lands early records show this in words which we can read. Here the record exists only in stone.

Usually articles which required much drilling of any kind, were blocked out before this was done. Thus all percussion was avoided after the perforation was complete, while sufficient material was left to allow for any deviation from right lines in drilling. Grinding and polishing then safely proceeded. Polishing and perforation sometimes went on together with disastrous results, a break in the surface spoiling the pipe or banner stone. The extent to which this drilling was carried is often surprising and the same may be said of its accuracy, specially when, as in many tubes and banner stones, it was made from both ends, meeting in the center. In its way it was as great a feat as some modern tunneling. Rarely does it deviate from a straight line.

CELTS

The grooved axe, as will hereafter appear, is rare in most of New York, and its place is supplied by some of the many forms of celts, often known as deer skinners. These are occasionally roughened toward the upper part of the lateral edges, to give a better grip to the handle. These axes were in use when Champlain encountered the Mohawks on Lake Champlain in 1609, although some had already obtained iron axes from the traders, who had frequented the lower St. Lawrence for more than 70 years. He was surprised that they could do so much with such poor tools, and these must have been far more effective than most antiquarians have thought, for in this instance fire was not used. He said they 'began to hew

down trees with villainous axes, which they sometimes got in war, and others of stone, and fortified themselves very securely.'

Usually, according to David Cusick, fire was applied to trees, and when these were felled, fresh fires were kindled where these were to be cut off in lengths. The fire was the active agent; the celt or stone axe was employed in scraping away the charred wood. Each woman had several fires to attend, and the work was done quite rapidly. At Onondaga now, the Indians use the same means in hollowing out the large wooden mortars still used by them. Burning and chipping go on alternately, a process familiar to our own early settlers.

The mode of handling is of interest, but was not always the same, and many ways have been described. Fig. 1 presents one remarkable and antique example. It is a celt of the common rounded form found in the peat and muck at Chittenango Creek long ago, seven feet under ground. It is the only ancient handle locally preserved, and has suffered much from age yet it is still fifteen and one half inches long by two and one quarter broad. It tapers from the axe to the end of the handle. The orifice in this is shown at *b*, and has evidently been finished, at least, by heat. In this the fine greenstone celt, elliptical in section, exactly fits. This is five and three eighths inches long and two wide, the form being quite common. It was dug up in excavating for the canal feeder.

Fig. 2 is an angular form of brown sandstone, found in the town of Cicero, four and five eighths inches long by two and one eighth wide. This form seems more frequent in New York than elsewhere, and is from four to six sided in its varieties, the angles never being rounded. One of the surfaces is always broad and flat, and two of them meet the others at a broad angle. They are somewhat common at Onondaga and Oneida lakes.

Fig. 4 is of an unusual form and material, being a very broad and flat celt of green striped slate, three and three quarters by three and one eighth inches. The outline is much like that of a modern axe, and it is much twisted in section. This was found, with a similar one, at Jack's Rifts, on the Seneca River.

Fig. 6 is a chisel of brown sandstone, almost cylindric, but with several flattened sides. These sides are nearly parallel. It is five

and five eighths inches long and one and one eighth inches wide, with neatly rounded ends. It is a rare form, and was found at Baldwinsville.

Fig. 7 is also a somewhat rare, but widely distributed form. It is flat or nearly so on one side, and more convex on the other. They usually have a broad cutting edge at one end, and are rounded at the other. This one comes to a sharp point, and is rounded and sharp at the broad end. It is of grey sandstone, three and one eighth by nine sixteenths inches and comes from Wood Creek, east of Oneida Lake.

Fig. 8. is of the normal form of this type, and is of brown sandstone, four by three quarters inches. It is sharp at both ends, the more pointed one being rounded, and comes from Baldwinsville, where they are somewhat frequent.

Fig. 9 is of green striped slate, and approaches the boat form. The ends are rounded and sharp. It is four and one eighth inches by three fourths deep, and comes from Chittenango Creek. There are many of this form, but their use is not clear.

Fig. 10 is another of the angular celts, and a still rarer form. It is of brownish drab sandstone, eight inches long by two and one eighth wide, and of a tapering form. There is a raised medial line on each broad surface, which, for half the length, has been gradually ground down to the broad cutting edge. The small end is brought to a neat point. Angles like these are hardly rare and yet are seldom so pronounced. This comes from the village of Baldwinsville.

Fig. 11 is a small black basalt chisel, angular and sharp, two and one eighth inches by one fourth broad. It is a very neat specimen of these small implements, and comes from Seneca River. Fig. 12 is another of these small celts from the same place, but thicker and more ridged on one side. It is of greenstone, two and one quarter inches long by three eighths wide. These are not rare.

Fig. 13 is a larger form of black basalt, triangular in outline, and with angular edges. It is three by one inches, and was found near Syracuse.

Fig. 14 is a handsome black and angular celt, with convex edges and somewhat rare form, three and seven eighths by one and seven

eighths inches wide, polished and from the Oneida River. Fig. 15 is also not a common form. It is nearly triangular and of light olive green slate, two and three fourths by one and one half inches. It is both thick and sharp, and has a very convex edge and comes from Seneca River.

Fig. 16 is much like one before described, and was found with it. It is of dark green striped slate, four and one half by two and one half inches, and is longer, narrower, and less twisted than the other. They are of moderate thickness, and no others have been reported at all resembling them.

Fig. 17 is a curious quartzite celt from the Mohawk River, being highly ornamented with lines and circular indentations, and having both sides thus carved. It is two and one quarter by one and one half inches. Celts are often thus ornamented, though not so profusely as this.

Fig. 18 is small, thin and symmetrical, with a cutting edge at each end. This feature is hardly rare, and appears in much larger specimens. This implement is but one and three fourths inches long by one half wide, the flat sides neatly curving to the sharp ends.

Fig. 18*a* is another very broad black celt of small size, one and three quarters by three quarters inches. Both are from Seneca River.

Fig. 19 is of grey sandstone with indented edges, and rather flat. It is five and one half inches long by two and one quarter broad, and was found at Onondaga Lake.

Fig. 20 is a beautiful and remarkable celt of green striped slate, from Onondaga Lake. It is quite broad, being two and one fourth by one and one half inches, and is remarkable for a depression across the surface half an inch from the edge, which has a flat grinding below this. It seems unique. Fig. 21 is grooved in a very different way, having three grooves across the back. It is thick and flat, of light olive green slate, and is five and one eighth by two and three eighths inches. It was found by the Oneida River, at Caughdenoy.

Fig. 22 is peculiar in many ways, having grooved lines lengthwise and across. It is four and one eighth by one inch, and comes

from the Thousand Islands. Fig. 23 is from the St. Lawrence River, and is one of the long and slender celts, widest in the center, flat on one side and curved on the other. The ends are rounded. It is of striped slate, six and seven eighths inches long, seven eighths wide and five eighths deep. Fig. 24 somewhat resembles this, but is more distinctly a double edged celt, being quite sharp at each end. One side is slightly but not conspicuously flattened, and a groove extends nearly around it. The other side is more rounded. It is of polished brown stone, three and three eighths inches long by one inch wide, and comes from Fleming, Cayuga County. Fig. 25 is of the same class, small and narrow, with curving sides. One surface is flat, the other raised, and while it is sharp only at one end, the other comes nearly to an edge. The form is wide spread but not common, and some specimens approach the boat stones in general outlines. They are usually of slate or fine sandstone. This one is from the Oneida River, and is two and three eighths by five eighths inches wide.

Fig. 26 is reduced in size with the nine which follow it. It is of a rare and peculiar celt, several of which have been found. They are very slender, usually nearly cylindric, and more or less pointed at each end. Sometimes the material seems too frail for use. This is one of the larger specimens, and 11½ inches long. The diameter is one by one and one fourth inches. It is angular and four sided, but the angles are rounded, and the points likewise. It tapers to each end, and shows no signs of use. The material is a polished dark gritty slate, from Seneca River.

Fig. 27 is another of the same general form, nine inches long by fifteen sixteenths thick. It is of a dark brownish steel grey, and is pointed at both ends. It was found near the Willard Asylum on Seneca Lake. This is of about the average length, but some are longer, and others more slender.

Fig. 28 seems an adze, and will be described under that head.

Fig. 29 is an unusual form of celt, contracting toward the point. It is made of green variegated slate, three and one half inches by one and one eighth wide, and is narrow and rounded at the cutting edge. It comes from Seneca River.

Fig. 30 might be classed as an adze. One surface is nearly a plane, and the other curves to each sharp end. It is of sandstone, nine and seven eighths inches long by one and three eighths deep, the width slightly exceeding the depth. It is from Brewerton, and a rare form for the size.

Fig. 31 is a small celt of variegated grey granite, from Van Buren. It is one and five eighths inches long by one and one eighth wide, and is quite flat on one side. Fig. 32 is larger and less angular, but of the same broad form. It is of a highly polished dark green marble, almost black, two and one eighth by two inches wide, and rather thick. The edges are rounded, and it comes from Seneca River. Fig. 33 is another of these small celts, made of black basalt and moderately broad. It is one and one half inches long by thirteen sixteenths wide, and comes from an early stockade on the Seneca River.

Fig. 34 is of black basalt, and is from a recent stockade in Pompey. It is an Onondaga implement used about A. D. 1630, and interesting in this way. It is thin, flat and angular, five and three eighths inches by two wide, and the edge is abruptly ground. It was found in 1878.

Fig. 35 is another of the small broad celts, from a place on the Seneca River where many of this form have been found. It is of basalt, one and three fourths inches by one and five eighths wide, the extreme width almost equaling the length.

Descriptions are added of a few celts not figured here, but all of which are described and illustrated elsewhere.

A fine angular and rather flat celt of black limestone is from Brewerton, and is nine inches long by two and three fourths wide. It has a fine polish and sharp angles, the latter being quite common with this form. Another, from the same place, is of black basalt, and almost triangular in section. It is quite large, being $11\frac{5}{8}$ inches by two and three fourths wide. A fine angular celt of grey sandstone is also from Oneida Lake, and has a narrow back and sloping sides. Many of this peculiar form are found near there. This is five inches long by two and three eighths wide. Another of this frequent angular form is of basalt, and comes from the Seneca River.

It is three and three fourths inches long by one and three fourths wide.

A fine celt of light olive greenstone is from Skaneateles, and is seven inches long by one and five eighths wide, being narrow for its length. A long triangular celt from the Seneca River may have been an adze, and is much ridged on one side. It is eight and five eighths inches long by two and three fourths at the widest part.

One interesting example is of a celt of brown sandstone, the edge of which has been broken. At some distance from this the implement has been nearly half cut off, in order to form a new edge. The original length was five and five eighths by two and five eighths inches wide. It is from a much frequented site at Onondaga Lake.

Very many fine celts are of a mottled greenstone, and usually not angular, being of the general form of the first figure given. Two beautiful examples of these from the Seneca River are each five inches long by two and one quarter broad. This is a frequent form and size. One of dark greenstone, thin and flat, from Onondaga Lake, is perforated at one end, and like implements occur elsewhere. This article is four by one and one half inches, and all the edges are convex. Several double edged celts are from two and one half to four and one half inches long.

A grey quartzite celt, from Three River Point, has a slight roughened groove entirely around it, which is picked as well as the battered end. The size is eight by three inches. Of course this occasional groove or roughening was not needed in small celts. A curious one from the Oswego River has notches on the lateral edges like those of sinew stones, and reaching nearly the whole length. A perforation had also been commenced. The implement is four and five eighths by one and five eighths inches wide. Another from the same place is remarkable for having the date of 1700 upon it, as much weathered as any part. The edge is broken, and it tapers quite to the upper end. It is of ferruginous sandstone, five inches by two and one half wide. Another from the Seneca River has also transverse grooves on the edge. This feature is hardly rare. It is of a light grey and quite hard stone, three and seven eighths inches by two wide.

About half remains of a large celt found on the Seneca River, and made of polished greenstone. The fragment is now seven and one fourth inches long by three and five eighths broad, and is two inches thick. There are few New York celts as massive as this. One of the four sided angular celts from Oneida Lake is of light drab sandstone, and has the lower surface or back about half the width of the upper, which is a frequent proportion in these. It is nine and three eighths inches by two and seven eighths on this broad surface, and is correspondingly thick. Another from Brewerton has all the angles rectangular in section, and is about half as thick as wide. It is eight and one half inches by two and five eighths broad. One from Van Buren made of polished black basalt, nine and five eighths by two inches, has the upper side angular, and the lower side partly angular, partly rounded. Occasionally a celt is very broad, as is one of mottled greenstone from Onondaga, which is three and five eighths inches by two and three eighths broad. The general outline of this is a broad ellipse.

A frequent form, but of polished green slate, comes from Seneca Lake. It is almost pointed at the top, but moderately thin and generally rounded. It measures five and three fourths inches by two and one eighth wide. A larger angular one, from the same place, has the ends rounded, and one broad surface as usual. The sides are sloping and the back narrow. It is of grey slate, ten inches long by two and one half wide. An angular six sided celt from the Seneca River, is of a hard grey stone, five and one fourth inches long by two and one half broad. A broad celt of greenstone from Cayuga County, straight on one side and curved on the other, may be an adze. It has a central perforation, much enlarged on both sides. It is five and one half inches long by two and three eighths wide, and is one and one eighth thick. It is a rare form in every way. One of the narrow celts, flattened on one side and raised on the other, and suggestive of boat stones, comes from Binghamton. It is nearly sharp at both ends, and is four and three eighths inches long.

Several of the long cylindric celts have been found in various places, and among them is one of black slate from Schoharie

County. It is slightly angular, having a distinct edge on each side. One end is rounded, with a very narrow cutting edge at the other. It is nine inches long, with a maximum thickness of one inch. Another of brown sandstone, slightly flattened, is from Cayuga County. It is eight and three fourths inches by one and one fourth thick. The ends are rounded, terminating the tapering surface. Still another from Elbridge is very fine and slender, being now $11\frac{3}{4}$ long by one inch broad. It is of sandstone, and apparently about an inch has been newly broken from one end. It is circular in section, and tapers as usual, but seems unfitted for any use as an implement. All these are certainly very curious.

A large celt from Plattsburg has two knobs on the back, or rather projections. A large gouge from Oneida County has similar features. These may have been left for attaching a handle. The celt is quite angular and thick, and is nine inches long by two and one quarter wide. This feature is rare. The largest perfect celt brought to our attention is from Jefferson County. It is of greenstone, and is $13\frac{1}{2}$ inches long by three and one fourth broad. Another large chipped one, from Plattsburg is 11 inches long by four and three eighths wide.

A fine angular celt of grey stone, from Three River Point, is quite thin, with one side flat and an expanding edge. It is four and three fourths inches long. A single celt of white marble has been found on the Seneca River. It is somewhat angular, and is four and one half inches long by two wide. Only one soapstone celt has met our eyes, and this came from the same river. Although angular, it is neatly rounded and finely polished, with an expanding edge. It is three and one half inches by one and one half broad. An article of soft red iron ore has the celt form for convenience merely, the grinding and cutting showing that it was used for paint.

One form, which is not frequent, is of a cream colored stone, very light in weight, first chipped and then finely polished. They occur mostly on the Seneca and Oswego Rivers. One from the former is four inches by two and one fourth broad, but they are usually narrower, forming a long ellipse. Another, a little differing from these, is from Oswego Falls, and made of a light chalky stone, $10\frac{1}{2}$

inches long by one and one half wide. It seems scarcely hard enough for much use, but the yellower ones are of a finer and harder grain, although so light in weight.

In Mr. A. E. Douglass' collection, out of 721 celts 85 are from New York, and about half of the smaller forms termed chisels. Dr. Abbott figures one New Jersey celt with a distinct groove, a frequent feature in New York, where all forms are abundant, some being local and unique.

GOUGES

Stone gouges are mostly found in the Atlantic States and are somewhat local there. They might be distinguished as the long gouges, tapering and evenly grooved from end to end; long gouges grooved part way; and broad gouges, distinguished in a similar manner. This would be but a broad classification. Long gouges have been found in Pennsylvania, although rare there. Dr. Abbott figured but one in New Jersey, where they are also rare. Two like his Fig. 140 have been found at Oneida Lake. In Saratoga County and vicinity, Mr. Wagman procured 29 gouges, the largest nine and one half by two and one half inches, and none of them were wider. He catalogued also adze gouges, probably meaning the broad forms.

Mr. Douglass has 85 gouges and adzes, of which 16 came from New York. Those in Central New York are mostly from Seneca River, Oneida, Onondaga, Skaneateles and Cross Lakes. They are most common near lakes and streams, and this makes it probable they were used in making canoes out of trees before bark was employed. They were unknown to the Iroquois. Out of 75 before us, more than one third are the long gouges, grooved from end to end, and tapering uniformly. Some are superb specimens.

Fig. 36 is a gouge of a beautiful light bluish striped slate, of unusual form and probably the finest known in this material. It is flat above and moderately rounded beneath, having a groove extending nearly half the length. The thickness is quite uniform throughout. It is seven and three eighths inches in length and two and one eighth wide, and was found near the Oneida River. It would hardly seem that it could have been employed in any common use.

Fig. 37 is a broad and flat gouge of brown hæmatite, from Van Buren. The broad depression is carried from end to end. Most of those of this form are of the same material, which is quite smooth but shows abundant pits with the polish. On this one an Indian and arrows have been marked with a fine point, doubtless by a much later hand. It is three and three fourths by two and one fourth inches wide, a common size.

Fig. 38 is a small gouge of the long variety, made of brown sandstone, three and three eighths by one and one half inches. It is from the north shore of Oneida Lake, and is grooved from end to end. Fig. 39 is also a small one, probably originally much like the last. It seems to have been broken, and then ground down to a celt-like edge, having part of the groove unchanged. Others occur where this has been done. This is of black basalt, and was found at Brewerton. The top is probably unaltered, and the present size is two and seven eighths inches by one and one fourth wide. For most purposes it is a gouge still. Fig. 40 presents the same feature, very little of the groove remaining. It is of grey sandstone, now flattened by this secondary work, and is four and five eighths by one and three fourths inches.

Fig. 42 is a very broad gouge from the vicinity of Oneida Lake, made of greenstone, and six and one fourth by two and one half inches. The broad groove is but two and one half inches long. Fig. 43 is much like this at one end, having a groove of similar outline. At the other end, however, the lines of another groove take a reverse sweep. Both ends are depressed. The material is greenstone, mottled with white, and the dimensions are four and three quarters by two inches. It was found near the Oswego River.

Fig. 45 is a fine long gouge of the usual size and form, from Oneida Lake. It is of black basalt, eight and one quarter by two and one quarter inches. Some others there were much larger. These long gouges are frequent, varying from four to ten and one half inches long, and they are always finely finished, but are not so common as the other forms. They occur throughout the St. Lawrence drainage in the East.

Fig. 54 is one of those we have termed long gouges, but it has a broad smooth groove across the back, not unique and yet a rare

feature. It is one of the finest examples of the kind, and is made of dark olive green slate, five by two inches. It was found on the Seneca River, west of Cross Lake. Fig. 55 has a somewhat similar dorsal groove, and is of ironstone, with a sharply ridged back, beveled down to the cutting edge. In section it is triangular, and the dimensions are four and one eighth by one and seven eighths inches. It was found near Cayuga Lake.

Fig. 61 is a broad gouge of rare form, closely resembling that of some celts. It is a handsome mottled stone four and one eighth by two and three eighths inches, and comes from the Oswego River. The back is ridged, and the central part of the upper surface at first slightly depressed, then quickly hollowed to the edge. Both ends are neatly rounded.

Fig. 72 is a reduced illustration of a curious implement combining the celt and gouge. The groove extends about half way from one end, while the other, which is broader, has a chisel edge. Toward the gouge end it is three eighths of an inch thick. It is picked and ground, and the dimensions are two and three fourths by one and three fourths inches. It comes from Seneca Lake.

An angular gouge of green gneiss from Jefferson County, has an angular groove, ending squarely at the upper end about midway in the implement. This is an unusual feature. It is six sided in section, nine and one eighth by one and three fourths inches wide, and is every way a remarkable article. Another large and curious gouge is from South Lake, Herkimer County. It is of black ironstone, and has a deep and long secondary groove in the center, with finer ones on either side of this. The length of the implement is $12\frac{1}{4}$ and the breadth two and one fourth inches.

Usually dorsal grooves are confined to the long gouges, but one from Brewerton, having the gouge cavity about one third of the length, has a broad and deep groove across the back, with a broad and shallow one above this. The back is somewhat flat, while the front is much curved. It is of light cream colored limestone, four and one quarter by two and three eighths inches wide. A long gouge from the same place is much contracted at the upper end, and is picked all over. It is of sandstone, six and seven eighths

by one and one half inches. A long gouge of black basalt from Skaneateles has a bulge in the back, but no dorsal groove. It was found in 1884 and is five and three eighths by two inches. Not far from this, in Spafford, a broad and thin ironstone gouge is three and seven eighths by two and one eighth inches.

A curious gouge of black basalt, from Oxford, has several knob-like protuberances on the back. The dimensions are seven and one half by two and three fourths inches. A long and deeply hollowed gouge from Oneida River, three and five eighths by one and five eighths inches, has two grooves across the back; and Pompey furnishes a long gouge of greenish grey stone, with the same feature. This implement is thick, but not of great length, the dimensions being four by one and seven eighths inches.

One beautiful long gouge from the Oneida River is of red slate, a very unusual material. It is seven and three fourths by two inches. One of black basalt from Cross Lake is both large and fine, being $10\frac{1}{2}$ inches long and two and one half wide. Another of greenstone, from the Oswego River, is of a long tapering form, flat above. This is nine and three fourths by two and one half inches.

Broken gouges are frequently found. Fanciful uses have been ascribed to them, but it can hardly be doubted that they were employed in aboriginal carpentry, the shorter forms being often fitted to handles. In making the dug-out canoe they would have been very useful. The wide difference in material and form, however, suggests artisans of differing nations, but they were probably used only for a very limited time, as they certainly were confined to a moderate area. The makers have left so few traces that little can be conjectured regarding them. Only this we know, that they had no practical relationship to the later Indians.

ADZES AND HOES

Stone hoes and spades were but sparingly used in New York, as other materials were employed in the rude agriculture practised here by the aborigines. Loskiel says that the Delawares and Iroquois ' used formerly the shoulder blade of a deer or a tortoise shell, sharpened upon a stone and fastened to a thick stick, instead of a

hoe.' The Mohawks used wooden hoes. Corn, beans and squashes were the staple products, and rude implements sufficed for these. Some celts may have been adzes.

Fig. 28 is a curved celt-like implement of polished sandstone, from the east end of Oneida Lake.

The sharp end is almost pointed, while the other is rounded somewhat like a ball. This may have been used as a pick or a hoe. It is nine and one fourth inches long and one and three fourths thick, being reduced in the illustration.

Fig. 66 has been called an adze, spade or hoe and is a rare form in New York. It is of polished black slate, somewhat triangular in outline, and having a groove across the surface about a third of the way from the top. Below this is a large circular perforation. The size is four and one half by three and three quarters inches, and it is said to have been found near Canoga, on Cayuga Lake. It is a western form, and finely finished.

STONE BALLS

Stone balls were often employed by the Iroquois in the heads of war clubs, a hard knot sometimes serving the same purpose. Some Onondagas still preserve such stones used by their ancestors. They occur moderately on most Iroquois sites, whether early or recent, and generally show irregular facets, though sometimes quite globular. They are not usually large, but in one instance at least the size is too great for a war club. They are occasionally grooved, and many elliptical pebbles occur with this feature, which were probably sinkers, and had no relation to warfare. These are abundant on some lake shores, notably those of Cayuga and Seneca. In the West stone balls have been used by the Indians somewhat like slung shot, and they were well known as bolas in California and elsewhere. In New York the more elaborate stone balls may be considered recent. Although perforated stones have been said to have been used as weights for fire drills by the Iroquois, there is no proof of this in early days, as they do not occur on Iroquois sites; and a mistaken impression has been gathered from Morgan, who makes no mention of a stone in describing the fire drill.

Fig. 47 is a small, black and polished ball, out of a large quantity found together in an Indian cemetery at Dresden, on Seneca Lake. One of these is an inch in diameter, and another a little larger. They are not quite a perfect sphere. Fig. 53, from a stockade on the Seneca River, closely resembles these, and is an inch in general diameter, but is a little oblong. It is black and polished, and is quite heavy.

Fig. 49 is one of the larger balls, probably used in war clubs. It is of polished quartzite, naturally grey, but stained dark and with russet streaks. A distinct flattened zone encircles it one way, but is not conspicuous, and there are obscure facets. The diameter is about two and one eighth inches. This comes from the Onondaga town of 1696, near Jamesville. A large granite ball, one foot in diameter and worked all over, comes from the same place. It may have been used in games.

Fig. 51 is a ball of pink quartzite, faceted, picked and ground. There are four facets on opposite sides, and another begun. It is two and one half inches in diameter, and was found on a village site near Baldwinsville.

A polished brown sandstone ball was found near Amboy, which was covered with red paint, and was three and one fourth inches in diameter. A very irregular faceted one of brown sandstone is from Indian Hill, occupied by the Onondagas in 1654. It is two inches in diameter, and ground but not polished. One of picked ironstone was long in the possession of the Webster family, on the Onondaga Reservation. It is two and one fourth inches in diameter, and a little irregular. Many such balls are found in Cayuga County, where oblong grooved pebbles also occur. A large grooved ironstone ball, on the Onondaga Reservation, is unpolished, and three and seven eighths inches thick. A spherical one comes from Indian Hill.

Near Baldwinsville they are frequent on fortified sites, and elsewhere. One of light greenstone, from the double walled fort, has distinct facets, and is one and three quarters inches in diameter. Another, from the same place, is of light greenstone and has irregular facets. The diameter is two and one quarter inches, and it is

a little flattened. Many more might be described, but they present no very different features. The largest of these is three and three quarters by two and one quarter inches, and is of flesh colored granite.

Among the grooved pebbles is a long one, closely resembling one from Wyoming. It is grooved all around from end to end, the length being three and three quarters and the width one and three eighths inches. This is classed among the sinkers, which usually have the groove around the shorter circumference in New York.

A figure of a perforated ball of polished yellow granite was omitted from some doubt of its character. It was obtained near Cross Lake some years ago, and two and one eighth inches in diameter by one and five eighths inches. The perforation is countersunk at each end, the general diameter is a quarter of an inch, and it is neatly drilled. In 1897, however, Mr. A. G. Richmond received one of these from Otsego County, of which he says, 'This is a smooth stone, about two and one half inches long, one and three quarters in diameter, and with a hole lengthwise a quarter of an inch in diameter. It is something so unusual for this part of the country that I desire to call attention to it. It was a surface find in that county.' The two articles so closely correspond in size and character that they may be classed definitely among New York articles; the principal difference being that the first mentioned is drilled through the short diameter. Mr. Richmond would place them with the South American bolas, but the perforation of so hard a stone would suggest some other use. The figure is so simple as to be readily understood without illustration.

ORNAMENTS

For convenience in arranging illustrations, some of the small ornaments are not placed in consecutive order, but will be found at intervals among the rest. Early stone ornaments, aside from those classed as amulets, gorgets and ceremonial stones, were usually of slate, soapstone and sandstone, and were not many in number. Other things were more available and made more show. A little before A. D. 1700, catlinite, or red pipestone, was brought east in

small quantities, and soon became quite abundant. It assumed many forms, and was commonly delicately perforated for suspension, often having a double parallel perforation for the purpose of keeping it exactly in place. By this time the Indians had many steel tools, and handled them with native taste and skill, fashioning many simple ornaments for themselves. They became good gunsmiths, good silversmiths, and spared no time to make an article good. Plain circular ornaments, which were often but flat rings, were favorites, and these must have been laid out with compasses, which they had very early learned to use. Many articles were straight sided, and almost pyramidal in outline. Some pieces of stone were wrought into fishes, and others into human masks, often very small in size. Any ornamental form was useful, and some were derived from the whites. The gradual change in ornament is easily seen, particularly on the historic sites in the counties of Cayuga, Montgomery and Onondaga.

Fig. 5 is a characteristic example of the red pipestone ornament, nearly one and one half inches long and over three quarters wide at the base. It is less than a quarter of an inch wide at the narrow end, and there are small and shallow indentations all along the two longer edges, and on both sides. A double perforation extends from end to end, and is very small. This is from Oneida Lake. Fig. 41 is of the same material, and is of a dagger form, with a long groove on the face. It is a little over an inch in length, and comes from an Oneida site near Munnsville, in the vicinity of which the Oneidas long dwelt.

Fig. 44 is of an older and more curious article, from a site occupied by the Onondagas about A. D. 1600. It is a piece of sandstone almost square; in general appearance like the nut used with a screw. It is perforated like that, and is slightly convex on one side and concave on the other. One broad surface is grooved. The diameter is one inch.

Fig. 46 comprises figures of three stone beads, made of small drab colored concretions, from Chaumont in Jefferson County. Fig. 52 shows more from the same place. They are more commonly made from some perforated fossil, like the encrinite stems,

known in Scotland as St. Cuthbert's beads. Fig. 48 illustrates another and larger kind by two views. Natural concretions often become rude ornaments.

Fig. 50 is a heart-shaped ornament of sandstone from Oneida Lake, perforated near the top for suspension. Length seven eighths of an inch. Fig. 57 is a triangular ornament of red slate from Cayuga. The edges have a concave sweep, and it is less than an inch long. Fig. 56 is from the same vicinity, being a large pipestone ornament, with two perforations as in a gorget. It is rounded at the ends, and the sides are nearly parallel. It is flat and of moderate thickness, and the groove is parallel with the edge, except at one end. The length is three and one half and the breadth one and one quarter inches. Fig. 59 is of the same material and from the same county. It is a flat rectangle, with a circular central opening, and one perforation for stringing. Diameter a little over an inch. Fig. 60 is a flat truncated pyramid in outline, and from Onondaga County. It is perfectly plain, and has one longitudinal perforation. Length one and five eighths inches by one and one eighth wide.

Fig. 58 is a figured pendant of red slate from Cayuga. It is a circular disk, perforated for suspension at the edge, and adorned with irregular lines on each side. Carved disks and pebbles are usually recent. The diameter is one and one fourth inches. Fig. 82 is a flat ring of pipestone, one inch in diameter. These are common, as well as some of the forms already figured.

Fig. 84 is a long parallel sided article of light drab slate from Fish Creek, east of Oneida Lake. The ends are rounded, with a perforation near each. It is flat and polished, and the length is one and three fourths inches. Fig. 87 is a small four-pointed star of pipestone, with rounded ends. It was found at Oneida Lake, and is eleven sixteenths of an inch from point to point.

Fig. 88 is of three rude stone beads from Cayuga Lake. Two of these are flat, but the smallest is thick.

Fig. 126 is a small notched and polished pebble from a stockade site on Seneca River. The material is greenish slate, and except in size and finish is precisely like the flat notched sinkers. Long

diameter eleven sixteenths of an inch. Fig. 127 shows two from a recent Cayuga site, a very little longer, but otherwise like the last. The use is conjectural.

Fig. 138 is a straight sided but tapering flat ornament of pipestone from Cayuga. It is two and three sixteenths inches long, and very narrow. Fig. 148 is of the same material and from the same locality. It is a rectangular disk, with a central circular opening, and two small perforations; one on each side. Fig. 149 is another long pipestone ornament from Munnsville, with straight converging sides. Fig. 150 is rarer, but of the same material and from the same place. It is a small trefoil, showing a human figure on one surface. Length thirteen sixteenths of an inch.

Fig. 162 is a remarkable article from a much frequented early site on Onondaga Lake. It is a cup-shaped highly polished pendant of brown sandstone, perforated at the base for suspension. The inside distinctly shows the work of the rimming tool, but the outside has been carefully polished. It is nearly an inch in diameter, and seems unique here. A similar broken one has been found in California.

Fig. 181 is one of the pipestone ornaments with converging sides, but differs from most in rising to a ridge in the center of each surface. There is a central longitudinal perforation. This is also from Cayuga County. It is two and one eighth inches long by a little over an inch broad. Figs. 182 and 183 are small dagger-shaped ornaments of pipestone from Munnsville; the latter perforated for suspension. Fig. 190 is another Cayuga example of the flat pipestone ring, perforated as usual. Fig. 199 is similar, and this form is very common on recent sites.

Fig. 194 is a small pipestone ornament from Munnsville. The sides are curved, and the general appearance not unlike that of a Masonic level. Masonic silver emblems were common among the Indians a little later. Fig. 195, from the same place, is heart-shaped, and dots are disposed parallel with the margin. It is perforated at the lower point. Fig. 198 has the form of some small animal made of pipestone. This is from Cayuga.

Fig. 196 is a stone ring from the Oswego River, and is moderately symmetrical. The work is fair, but coarse. The projection on one side is perforated, and it may have been used for an earring or ornament. Stone finger rings are rare. Fig. 197 is another from Fort Plain, and on the seal are a tomahawk and arrow. These are recent of course.

Fig. 210 is a cylindric pipestone bead from Pompey. This form is rare. Fig. 225 is a curious perforated ornament of stone.

Fig. 226 is a pipestone mask from Wisconsin, which may be compared with New York specimens. Fig. 227 is a small pipestone mask from a recent site in Pompey. Fig. 228 is a rude pipestone mask, nearly square. This is from Munnsville. Fig. 232 is a small pipestone mask from Onondaga Lake. This has a rim above as though part of a pipe, but it is perforated for suspension. It is very finely worked. Fig. 233 is a small pipestone mask which lay on a child's skull in a grave at Scipioville. Another rather rude mask comes from Cayuga County. Fig. 238 is another fine mask from the same county. It is of grey marble, slightly concave behind, and is larger than most good examples here. Fig. 239 is a cobble stone on which is carved a human face. The character is modern and it comes from near Cape Vincent.

Fig. 229 is a quatrefoil of pipestone from Munnsville. It has a circular opening, and is a rare form of ornament.

Fig. 230 is a curious little pipestone ornament with volutes. It is from Munnsville and equally rare. Fig. 231 is a pipestone fish from the same place. Fig. 234 has straight but not parallel sides, and is of pipestone. Besides the grooved lines mostly parallel with the edges, there is inscribed on it the name of 'Joheannes,' in a very neat hand. It was found at Auriesville. Fig. 235 has also straight but not parallel sides. It is of pipestone and from Cayuga. There is a perforation midway in the narrow top, and one near each lower corner. A broad groove runs parallel with three edges, and within this are fine cross lines. It is two and five eighths long by one and five eighths inches wide.

Fig. 237 is also from Cayuga, and of pipestone. The straight sides converge, but the basal line is quite convex. There is a small

superficial perforation at the top and bottom. Fig. 240 is a small pipestone ornament found with a skeleton near Onondaga Lake. There are two perforations. Fig. 242 is a flat oval ornament of common slate, perforated at the small end, and found on an Onondaga site of 1600. Fig. 243 is a small pipestone ornament from Cayuga, with converging sides. It is notched along the edges and perforated. Fig. 244 is similar, but parallel sided, and comes from Pompey. Fig. 245 is a flat serpent form of soft greenish slate, and part of the back has been cracked off. A well defined head and scales remain, as well as the general outline. It is much curved horizontally, is three and seven eighths inches long, and probably very early.

A turtle totem of grey stone came from an early cache in Cayuga. It had projecting head, feet and tail, and was perforated for suspension. A frog of green slate, found in Canajoharie Creek, is well proportioned and carved, but seems recent. A disk of green sandstone from that vicinity has on it a tree, 1774, and W. H. K., and such inscriptions are not rare. A curious hatchet shaped stone found there, has a fine wolf's head in relief. A remarkable ornament is from Belleville, Jefferson County. It has on it what seems a ship, and also a fish with feet. It is of red slate, and much like other recent articles.

With all the vigor of their ornamental work it is commonly easy to distinguish that done by the aborigines from that of the white man, with a moderate experience, and quite as readily may recent work be distinguished from that which is earlier. Little touches make the difference. In some places there are scores of small pebbles adorned with designs, and probably made and used by Indians, but they are almost always recent work. On the great subject of these distinctions we need not enter now, merely calling attention to it.

HAMMER STONES AND MULLERS

Stones with pits or cups are found throughout the world, and much has been written on their uses. Many of them were undoubtedly hammer stones, specially when made of small pebbles, easily used in this way. Even these, however, are not alike, and other

uses have to be imagined. The larger flat stones, with many cavities, are plainly of a different class, but they are not frequent in New York, and require little attention now. They are quite generally considered nut stones, used for cracking hickory nuts specially, and it may be allowed that many had this occasional use at least. North and south alike the Indians made large use of nuts, and there was general rejoicing among the Senecas in 1670, because hickory nuts were so abundant. From these and from sunflowers they procured an oil which they highly prized. That they had suitable implements for cracking or crushing these there can be no doubt. To the wooden pestle and mortar the Mohawks sometimes added the crushing of grain between two stones, and this was more necessary when the harder nut-shell was to be cracked.

That these pits were used as sockets for fire-drills is against all probability. The proper socket for these was the dry wood, which could be set on fire as intended, while the stone could not. That some were used as lap stones is almost certain, and it is perfectly clear that many could not have been hammers. Some may have been used in games, so neatly are they finished, but the subject of their use will not be farther discussed now. The present conclusion is that they had varied uses, some of which are now unknown.

The ordinary hammer stones are too well known to require many illustrations, while, at the same time, there is an almost infinite variety of forms and combinations. A flat polished surface makes a muller; a deeply pitted surface marks many kinds of hammer stones. Those with battered edges probably had this use. Others of soft materials show no traces of this; some approach the southern chungke stone, and may have been used something like that. Hammer stones, so called, are still found on Iroquois sites, but two centuries old, and may have come down to the present century.

Fig. 62 is a circular pebble of brown sandstone, and seems to have been worked into shape. There is an irregular pit in the center on each side, and it never was used as a hammer, being too soft. The diameter is three and three eighths and the thickness one and one half inches. It is from a hamlet on the Seneca River.

Fig. 64 is a double muller. The ends are somewhat convex, as is often the case, and it is finely picked around the very deep edge. This is also from the Seneca River, where many forms abound. It is three and one half inches wide, and two and seven eighths deep. Both these figures are reduced. Fig. 122 is a muller of quite a different character. The last might have been used in a game, but this probably would not have been. It is of greenstone, and has the upper surface picked, polished and rounded, with a depression in the center. The edge is picked, so that it forms a true circle, while the under side is flat and polished. It is four inches wide by two deep.

A fine implement comes from the Seneca River, and is a circular flattened white sandstone pebble, neatly chipped around the edges, and broadly depressed on both sides, this depression nearly reaching the edge. The diameter is four and one half inches. Another is an elliptic pebble of brown sandstone, three and three quarters inches in the long diameter, and about half as thick. It is ground nearly flat on one side, as though for a muller, the remainder being left untouched. This is from Onondaga Lake. Another elliptical sandstone pebble has been roughly ground at one end, as though to change the shape, and an irregular groove has been sharply picked or cut in the center. Many show this primary picking, the depression being made for use, and not by use.

A broad central line of white quartz passes through a handsome angular black pebble, which has been roughly ground at one end, leaving it now a hammer stone, but it may have been intended for the ball of a war club. Many hammer stones have double pits on one or both surfaces of the elliptical or circular pebbles. One from a stockade on the Seneca River is an oval brown sandstone pebble, four and one quarter inches the long way. Sharp and moderately broad cuts have been made in this, in the center, with a sharp tool.

A curious stone comes from an Indian fireplace in East Varick. The Indian soon saw the advantages of compasses, and used them on shell and stone. This brown sandstone pebble has a slight pit in the center, from which six concentric circles were laid out, intersected by a six-pointed star. A recent double muller of grey

quartz, finely polished, is from Indian Hill (1654), and is so neat and symmetrical that it may have been intended for some game. The diameter is two and one eighth inches, and the thickness one and one eighth. It is a beautiful article. One fifty years older comes from a stockade some miles south of this. It is a red sandstone pebble, with both surfaces convexly ground, and with a small indentation. The edges are picked, and it is four inches wide by one and five eighths deep. A combined hammer stone and muller is from Indian Hill, but it has the pit in the center of the flat side. The convex side is depressed, and the edge hammered. A fine nut stone from Rome, nearly six inches across, has three cavities on one side, one of them of a lozenge form.

A curious elliptic pebble of brown sandstone is from Onondaga Lake. It is ground and pitted as usual, and from this a sloping surface has been ground toward each end. One from Cayuga County has terminal grooves instead. On Mohawk sites mullers are also found with European relics.

Fig. 76 is an extremely small muller, but three quarters of an inch across. It is a circular sandstone pebble distinctly ground on one side, and was found on the Seneca River.

PESTLES

Pestles are everywhere found, as might be expected, but were very sparingly used by the Iroquois, who preferred their wooden pestle and mortar, as they do still. The Jesuit missionaries among the Hurons expressed the same preference, although they had a hand mill which the Indians delighted to turn. The primitive implements gave the best results. Mr. Fowke thinks the cylindrical pestle was used as a rolling pin, but has taken no notice of the long flattened pebbles, so frequent in parts of New York. It may be they were sparingly used elsewhere. Stone mortars are more common toward the coast, and the ordinary pestle or pounder must often have been used without them. Prof. G. H. Perkins described a pestle with a carved head in Vermont, and there is one of these in the State Museum at Albany. Mr. Wagman had a fine one of this kind from Lake George, with an animal head at one end. It was 24 inches long and two thick. Several have been seen in the

central part of the State. Mr. Wagman had 23 long pestles, varying from seven to 21 inches long. They are quite as large elsewhere, but vary in form.

There are very many small ones, of long cylindric pebbles, more or less worked, which can hardly have been used in pounding, they are so light. They may have been employed for mixing paint, or for rolling pins. The short truncated forms are rare in New York, nor are the well worked cylinders common. Ruder implements often sufficed.

Fig. 63 is a grey sandstone pebble, seven inches long, and much enlarged at one end. It shows work and use, and was found at Onondaga Lake. This, with those up to Fig. 74 inclusive, are reduced in the illustrations. Fig. 65 is a small angular pestle of sandstone, flat and with parallel sides. It has been picked into shape, and the top is neatly rounded. It is three and three eighths inches long by one wide, and is from Seneca River, where these simple forms abound.

Fig. 67 is a well worked pestle from the vicinity of Rome, much contracted at one end for a little over an inch of the length, and then expanding to a thickness of two and one fourth inches. Hence the edges converge in straight lines toward the smaller rounded end. It is eight and three quarters inches long and angular. Near the broad end is a large pit like that of a hammer stone, which is a frequent feature of these angular pestles, whether broken or perfect.

Fig. 68 is the finest example known of the carved pestles, if it may be classed with them. In the illustration it is more reduced than the others, being drawn half their size. It is 15 inches long, and two and one half broad in the widest part of the handle, if it may be so called, for it seems more of a war club than pestle. It is a long pebble of a hard brown sandstone, and the tapering end, where it was grasped by the hand, shows much use. The sides are flat and neatly rounded at the edges, which are otherwise angular, the implement being about half as thick as wide. The head is boldly but neatly carved, representing an animal's head with conspicuous eyes and teeth. These are not in relief but engraved. Both sides are alike, and the head is somewhat thicker than the

broad handle, from which it is also distinguished at the neck. The eye has two circular perforations, separated by a ring between. A deep cut forms the mouth, and notches on either side of this are the teeth. Although somewhat heavy for a war club it would have been an effective weapon, and the sole signs of use are at the contracted end, farthest from the head. This being so it can hardly be doubted that it was a warlike weapon.

Fig. 69 is a broken sandstone pebble, having a carved head with a mouth and raised eyes or ears. It was found in 1879 at an early site on the Seneca River. One side is flat, and the work is rude. It now measures six and three quarters by one and three quarters inches. A fine example of the carved pestle is in the State Museum, having a fish's head. Several have occurred near the Seneca River which have now disappeared.

Fig. 70 is a fine cylindric pestle from the Seneca River, which has been picked and polished. The greatest width, two and one fourth inches, is just below the center, and it is nine and one half inches long. A larger one, which has lost part of its length, is from the same stream. It is of a long, tapering and cylindric form, polished, but retaining a few pick marks, and is of brown sandstone. It is still $14\frac{1}{4}$ long and one and five eighths inches thick at the small end where it was broken. The thicker end is two and one eighth inches in diameter.

Fig. 71 is very frequent form on the Seneca River, and though it shows use in pounding, it seems to have been oftener employed in grinding, one side and edge being flattened by use. It is a brown sandstone pebble, and was found at Onondaga Lake. The length is eight and three eighths inches, and it is quite slender, the width being one and three quarters, with a thickness of one and one eighth inches.

Fig. 73 is a cylindric and truncated pestle of brown sandstone, which is perfect, and is five and one fourth by two and one fourth inches. Another of similar form is also from the Seneca River, and of a little larger dimensions. Fig. 74 is a truncated pebble, picked at both ends, and comes from the same stream. It is a cylindric sandstone, two and one half inches long by one and three quarters

thick. Dr. Abbott considered these hammers, but hammering and pounding are much alike.

Fig. 75 is a pyriform grey sandstone pestle from Onondaga Lake. It resembles a plummet, but is larger and not grooved. These would not be real distinctions, but while this implement has been picked and polished, the ends have been battered by use. It is four and one eighth by two and one fourth inches.

Fig. 89 is a good example of the small pestles probably used in preparing paint. It is of brown sandstone and quite slender, being four and five eighths by one and three eighths inches. It has slight pits, and is from the Oneida River. There are many like this, but usually larger.

Many large and rude pestles occur. One of brown sandstone, from Elbridge, is slightly spoon-shaped, having a small wedge-like projection at one end, useful for cleaving off bark, and this may have been its purpose. Except this it is rectangular in section, and has the sides nearly parallel. It is 24 inches long, with a general thickness of two and one half inches. Another similar and of the same material, comes from the same town. It is almost square in section, and quite straight like the last. The length is 17 inches, and it is two and one half by two and one quarter inches in thickness. These large and rude implements often occur in various places, and quite a number from Brewerton are full 18 inches long.

A curious but rude pestle of brown sandstone comes from the Seneca River. It is quite angular, and four of the sides are smooth. Between these the edges are roughly chamfered. One smooth side is grooved like a gouge at the smaller end, probably in sharpening tools, and there are pits at the larger end. It is eight and one fourth inches long, the greatest width being one and seven eighths inches. A flat sandstone pestle, from Oneida Creek, has parallel sides and compressed ends, with many pits. The dimensions are six and three eighths by two and five eighths inches.

One from Onondaga Lake has one edge perfectly straight, while the other is picked and curved, and has a transverse groove, perhaps for attaching a handle. Both ends show use. This is seven and seven eighths by two and seven eighths inches. A somewhat

cylindric but six-sided pestle is from Oneida Lake. The size is 19¼ by two and one fourth inches. This is a rude article, but a well wrought cylindric pestle, 11¼ by two and three eighths inches is from the same place. A flattened one of sandstone, from Oswego Falls, is 14⅞ by two and one half inches.

A pestle from Oswego Falls resembles Fig. 67. It is square in section and compressed at the larger end, whence it tapers to the smaller. The form is long and slender, being 18 inches in length by two and seven eighths thick. A pyriform pestle of grey sandstone is from Cross Lake, and is ground in lines toward one end. The length is three and one fourth and the thickness one and one half inches.

Though the Iroquois used stone pestles but little, one of the sandstone pebbles utilized as pestles on the Seneca River and elsewhere so freely, has been found on Indian Hill. It is 10⅜ inches long, perfectly straight most of the way on one side, and showing marks of human use. A cylindrical pestle of sandstone comes from Rome, and is nine inches long by two and one half thick. From the same place is another, compressed near the broad end and with pits on two sides. It tapers as usual, and is flattened. The ends are hammered. It is six inches long by two inches in diameter.

A large pestle with a carved head has been described, found on the Hudson below Albany. The eyes are sunken and the lips lined. The length is 26 and the diameter one and seven eighths inches. One cylindric pestle is from Seneca Lake, and is made of sandstone. It is nine and three quarters inches long and two and five eighths thick.

Quite curious forms occur in Tioga County. A massive squared one from Newark Valley is reported as being 15 inches long and five and one half thick, while other curious ones occur in the neighborhood. One from Owego, broadly shouldered below the handle, is 17½ inches long, six and one half broad at the base and four and one fourth thick. The shoulder is 10 inches above the base, and the weight 21 pounds. A similar one from the same place is 15 inches long and four inches in the greatest diameter. The handle is cylindric, the base being square, and eight inches long.

Fig. 85 is a curious little implement of fine brown sandstone, from the Seneca River. Although so small its form suggests a pestle, but it was probably a paint muller, as it is more adapted for grinding than any other use. It is rectangular both in section and outline, and is one and three eighths inches long, with a long diameter of three quarters of an inch. Both ends are flat, and might be used for grinding.

POTSTONE

Fragments of potstone vessels are found in many parts of the State, but perfect vessels are now very rare. The material was so easily worked that it was used for other things. Naturally the remains of vessels occur oftenest near navigable waters, as they were too heavy to carry far by hand. Among those in the Wagman collection was one with a handle, and such handles are usually more or less carved. The vessels are most neatly finished within, as a rule, and are often quite shallow. Outside, the base is often left rough and angular, perhaps that it may stand the better, or for finishing in leisure hours. The material was not procured in the State, although it occurs here, and probably most of the vessels come from Pennsylvania. Dr. Abbott mentioned none in New Jersey, nor have any been reported in Canada, where steatite pipes are common. Many fragments are perforated, and some have been worked over for new uses.

Fig. 77 is a section of a vessel restored from fragments found at Rome. The pieces were saved, put together, and this is a reduced figure of the vessel, which is 10 inches high and about 20 inches across the handles. The greatest thickness at the bottom is one and one half inches, and this is quite flat, although rounding quickly to the sides. The rim is thin, and this is a common feature. Many vessels are much shallower than this. One from the Oswego River is angular at the bottom, and the total outside depth in places is but two inches, the bottom being three eighths of an inch thick and perfectly flat. The curving rim of this is notched. Another, from the Seneca River, is also shallow, broader at the base than at the top outside, and nearly straight at top and bottom; the bottom diameter being four and three eighths inches. The inner side is nicely curved, and the fragment is perforated in one place. It may be that a better

finish was in prospect for the outside, which is quite rude. The broad handle projects one and one fourth inches, and has five straight grooves on the upper side, at right angles to the vessel. Straight rims, however, are often found.

Fig. 78 is a curious piece of potstone, somewhat like a door knob. It seems complete, and is neatly finished, but has no assignable use. When worked all over, however, steatite might seem finished in any stage. It comes from Onondaga Lake, and is two inches long, one and one half wide, and one deep.

Fig. 79 shows a notched potstone rim, and this form is frequent. Some rims have simply acute notches, while in other fragments they have a rounded form. The perforations are well known. Many fragments are curiously grooved, and one has two grooved edges and two perforations. It is now three and one fourth by two and three fourths inches across.

Fig. 80 is a potstone sinker, made from the curving side of a broken vessel. Grooves encompass it near each end. This is two and three eighths by one and one eighth inches, and one much like it has been found at Owego. The one figured is from the Seneca River.

Fig. 81 is a handsome notched and grooved handle, with part of the notched rim. The projection and width are each one and one half inches. This is a frequent size of handles. Fig. 83 is another broader and heavier handle, being from a heavy vessel found by the Seneca River, and then entire. It was left exposed, broken by frost, and carried off in fragments. If circular it would have been 13½ inches in diameter at the rim. The under side of the handle is smooth, and blackened with use. The upper is adorned with cross grooves. The projection is two and one fourth inches. Several carved handles might be described, and they project from one to three inches or more, with a corresponding width. In the Rome example, the projection is one and one fourth, with a width of two and three fourth inches.

STONE PLUMMETS

A very interesting class of stone implements is that of the plummets, which are somewhat local in New York. They have a very

moderate distribution here, but probably Brewerton, at the foot of Oneida Lake, has furnished more than all the State beside. Even there they mostly occur in a very limited area. They are not rare about Onondaga Lake, and these are the two localities of Central New York. Local specimens differ much from those of the West. It has been surmised that they had a superstitious use, but here they seem confined to good fishing places, and may well be classed as sinkers, although some of them seem hardly fitted for this use.

There are many plummets in the South, having the usual groove but also often perforated. They occur in New England, Ohio, and California. Out of 270 in his collection, Mr. Douglass had but 29 from New York. It would be interesting to know from what points these came. None have been reported from New Jersey. Dr. Abbott says that one was found in a mortar in Massachusetts, and Schoolcraft not only speaks of them in New Hampshire, but says that the Pennacook Indians used them as sinkers. The latter statement may be taken for what it is worth. The Eskimo have similar sinkers, but they are perforated. Among the California Indians it is said they were used as rain charms, and rude ones are found in the Florida shell mounds.

Fig. 3 is a small and slender, as well as rather flat slate plummet or pendant, slightly resembling the older ones. It is rather an ornament than anything else, and comes from a recent site in Pompey. It is placed here because of a likeness which is more apparent than real. The length is two inches.

Fig. 90 is a slender curved one, not of the usual form, but grooved in a frequent way. Near each end is an encircling groove to which a cord might have been attached. Across each rounded end is a connecting groove, often seen at the top of plummets. It is of dark sandstone and was found in Elbridge. The length is four and one half, and the thickness one and one eighth inches. A similar curved one of brown sandstone, from the Seneca River, is much flatter, and has tally notches on each side. This is three and seven eighths inches long, and one and five eighths broad the widest way.

Fig. 91 is a true plummet of fine polished grey sandstone, from Onondaga Lake, beautifully worked and of fine form. The groove

is unusually near the top. It is four and one fourth long by nearly one and one half inches thick. Fig. 92 is of flattened red sandstone, with a pointed eight-sided top above the groove. The body is also angular and rather irregular. This came from the Seneca River, between the lakes mentioned, and is three and five eighths long by one and one half inches wide.

Fig. 93 is of greenstone, generally cylindrical and slightly faceted. The groove is deep and the top simple. This, with several following, came from Brewerton. It is three and one half long by one and one half inches wide. Fig. 94 is very broad, and is polished and somewhat flattened. It is elliptic in section, and made of red granite. It has shoulders but no groove, and is two long by one and three quarters inches broad. A few closely resemble this. Fig. 95 is also shouldered, but without a groove, and is made of hornblendic gneiss. It is two and one half long by one and one eighth inches wide. Fig. 96 is of greenstone, has a square head, and is generally angular, with but slight curves. It is three inches long by one and three eighths wide.

Fig. 133 is of brown sandstone pyriform, and with a deep groove. It is two and five sixteenths inches long by one and three eighths broad. Fig. 134 has no groove, but one has been commenced. It is of quartz and four-sided, but with the angles rounded. It is two and one half inches long and one and one quarter broad. Fig. 216 is reduced in the illustration, and is of a flattened and angular green basalt, one and thirteen sixteenths inches long by one inch thick.

A faceted greenstone, two and three fourths by one and one fourth inches, has a small projection above the groove at the top. A few are very slender. One of polished brown slate from Catskill is of this kind. The outline is a long pointed ellipse. It is three and seven eighths long by seven eighths of an inch in diameter. Not unlike this, but with rounded ends is one of grey sandstone, from Brewerton. It is also less slender, being three and three quarters by one and one eighth inches. Many are ovoid and grooved, but angular forms are common. One of these, from the Onondaga Reservation, is eight-sided, the alternate faces being wide and narrow. It is of light brown sandstone, three by one and

one eighth inches. One of green talc, two and three fourths by one and one half inches, has many facets. This also is from Brewerton.

Angular forms are often thickest in the center. Quite a proportion have a cross groove over the end above the circular notch. A very irregular one of sandstone has about thirty facets, but this is unusual, and such a feature may be only preparatory to a finer finish.

SINEW STONES

Though the name of sinew stones may not exactly express the use of a familiar class of articles, it yet answers a purpose, the grooves being supposed to come from drawing sinews across the stone. The best examples are thus of rather soft sandstone, easily worn. The theory imagines this operation for making an even bow-string, not an unlikely thing. Dr. Abbott described one of these stones, and said they had never been figured before. They are not common, and yet have a wide distribution.

Fig. 86 is unusually fine, having many of these grooves deeply impressed in this brown sandstone pebble, and the other side is like the one shown. This is from Binghamton, and three and seven eighths inches long, which is about the usual size. A larger one from Oneida Lake, has grooves and notches, and is five and one half by two inches. Another, from Cayuga Lake, is almost triangular, and has deep grooves all around. This is three and one half by two and one quarter inches. A brown sandstone pebble from Seneca County, three and one half by two and three quarters inches, has grooves only at one end. These, of course, increase in number and depth through use. One, from Onondaga Lake, has deep grooves, and is three and one half inches long. One of grey sandstone, from Schoharie County, has similar grooves, and is four and one fourth inches in length. A much larger one of grey sandstone, from Oswego Falls, has but slight grooves, being a hard stone. Several come from Brewerton, but this enumeration will show their distribution and leading features. The drawing of thread through beeswax will illustrate their appearance and possible mode of formation. The general form, of course, will be that of the pebble, and the marks will vary with use.

STONE PIPES

Both clay and stone pipes are rare in New Jersey, and these are inferior to those of New York, where so many of the finest examples of both are found. Equally fine are those of Canada, where they are common. At first the Iroquois made clay pipes only, but afterwards used European tools on those of stone. The early and recent pipes are easily distinguished as a rule, but space will not allow a discussion of this, although a few early notes may be given.

In describing the Indians of New England in 1643, Roger Williams said, 'Sometimes they make such great pipes, both of wood and stone, that they are too foot long, with men and beasts carved, so big or massie, that a man may be hurt mortally by one of them, but these commonly come from the Mauguawogs, or the men eaters, three or four hundred miles from us. They have an excellent art to cast their pewter and brasse into very neat and artificial pipes'. These pewter, brass and iron pipes are still sometimes found, but the Mohawks made pipes of clay at the time to which he refers.

In the *Jesuit Relation* of 1653, is the account of a conference between a New England nation and the French. The ambassador 'seats himself in the midst of the place; he takes two great petunoirs, made of a green stone, beautiful and highly polished, a cubit long. This was the fifth present. He fills one of them with tobacco, puts fire to it, and sucks or draws the smoke out of it very gravely. All the assembly watched him, not knowing what he meant. After having well smoked at his ease; "My brother," said he "these two pipes, or these two petunoirs, are yours; it is necessary henceforth that we have but one breath and one respiration, since we now have but one soul".' These petunoirs may have been stone tubes, pipes sometimes taking this form, as they did in California, nor are straight pipes unknown here.

In his account of the southern Indians, Adair said, 'They make beautiful stone pipes; and the Cheerake the best of any of the Indians, for their mountainous country contains many different sorts and colors of soils proper for such uses. They easily form them with their knives; the pipes being of a very soft quality till they are

smoked in and used to fire, when they become quite hard. They are often a full span long, and the bowls are about half as large again as those of our English pipes. The forepart of each commonly runs out with a sharp peak, two or three fingers broad, and a quarter of an inch thick. On both sides of the bowl they cut several pictures, with a great deal of skill and labor.'

In his early account of the Narragansetts, Wood says, 'From hence other tribes have their great stone pipes, which will hold a quarter of an ounce of tobacco, which they make with steel drills and other instruments; such is their ingenuity and dexterity that they can imitate the English mold so accurately that were it not for matter and color it were hard to distinguish them; they make these of green, and sometimes of black stone.'

Capt. John Smith described the stone pipes, apparently, of the Sasquesahanocks, although they were of the Huron Iroquois family, which then used mainly clay pipes. In describing one of these gigantic men, he spoke of 'his tobacco pipe, three quarters of a yard long, prettily carved with a bird or beare, a deare or some such device at the great end, sufficient to beat out the brains of a man.'

In 1756 Sir William Johnson presented a great calumet to the Six Nations, and said, 'Take this pipe to your great council chamber at Onondaga. Let it hang there in view, and should you be wavering in your minds at any time, take and smoke out of it, and think of my advice given with it, and you will recover and think properly.' Gives the largest pipe in America, made on purpose. They replied, 'We assure you we shall hang it up in our council chamber, and make proper use of it upon all occasions.' This great pipe was used at the conference with Pontiac at Oswego, in July, 1766. Pontiac's pipe was lighted and handed around, and afterwards 'the Onondaga speaker lighted a calumet of peace, which Sir William left in their hands many years ago, for their use, and handed it about to the western Indians.' This probably disappeared in the Revolutionary war.

In his account of the conference between De la Barre and the Onondagas in 1684, La Hontan described the pipe of peace, and perhaps had in mind the one then used. The council assembled,

and he gives a plan of this. 'The Grangula sat on the east side, being placed at the head of his men, with his pipe in his mouth, and the great calumet of peace before him.' Then follows an account of the official pipe. 'The calumet or pipe, is made of certain stones, or of marble, whether red, black or white. The pipe or stalk is four or five feet long; the body of the calumet is eight inches long; and the mouth or head, in which the tobacco is lodged, is three inches in length; its figure approaches that of a hammer. The red calumets are most esteemed. The calumet is trimmed with yellow, white and green feathers.' He gave a small figure, both of the pipe and speaker, but little can be gathered from them. His description is general, and as he afterwards traveled in the West, it may have been made from western pipes. About this time, however, the red pipestone came into New York.

Mr. Douglass' collection has 43 New York pipes in a total of 375, but it is evident that they once existed here in great numbers. Besides those made by the Indians large quantities of pipe clay pipes were distributed at councils and treaties by the English, and these antique articles are frequent on the more recent sites. Certain forms of stone pipes are found throughout the Northern States, made within the last two centuries, and those of pipestone are confessedly modern. At present a very simple article suffices for the Indian's need in New York.

Fig. 97 is a remarkable pipe of black soapstone, with inlaid eyes of hollow bone. This fine pipe was found in a grave on the Seneca River, and with it were European articles. The handle beneath is a characteristic of part of the pipes of the historic period, and appears in much simpler forms. When this is found the age may be thus determined in a general way. The bowl is capacious, and the face very fine and expressive. This is turned away from the smoker, another feature of the later pipes, whether of clay or stone. It is four and one half inches high. A head-dress slightly appears, but not such as might have been expected.

Fig. 98 is of yellow sandstone, and was found in Cayuga county. The form of the bowl is both early and recent, and has animals in relief on the sides. It is one and seven eighths inches high. Fig.

99 is a short platform pipe, the bowl being much narrower the other way. Many of these platform pipes are of recent date, the earlier ones often having a curving base. This is from Onondaga Lake, and is one and seven eighths inches long by one and one fourth deep.

Fig. 100 is a black marble pipe from Jamesville, near the site where the Onondaga fort was burned in 1696. The situation, however, does not necessarily indicate its age, nor have we any certain guide to this. All examples of this form have the figure or face, where there is either, toward the smoker, which was an early fashion; otherwise the pipe would seem recent. This has a full length of a man, rudely carved, on the back of the bowl, and the zigzag ornament at the top has a modern look. The lines enclosing the figure, and the raised rim above it, appear in clay pipes made three centuries ago, and this is probably one of the earliest pipes made for or by the Iroquois with metallic tools. The extreme length is four and three fourths inches, about the average size of this form, which frequently occurs. There is, however, an Indian pipe, resembling this form but without the elevated projection and figure, which belonged to Tim Murphy, the noted rifleman and ranger of the Revolution, and which has his initials upon it. It is a little more angular, and is three and one fourth inches long by one and one fourth high. This is not far from the dimensions of some of these. These things suggest a modern date, strengthened by the localities where most of such pipes have been found.

One of these of a burnt sienna color, with a face on the back and a moulding at the top, has the same general character. It is from Baldwinsville, and is two and three quarters inches long. One of soapstone, four inches long, has an elevation like the Jamesville pipe, and is from the Oneida River. Another of the same character, from the Seneca river, is of white marble, and the extreme length is three and three fourths inches. Another with a human figure on the back is from Schodack. It is of yellow soapstone, and is larger than most of this kind. A white one from Root, Montgomery County, has a human figure, and is three and three fourths inches long. Two, with human faces and figures, come from Jefferson

County. Others might be described, and among these, those with two raised heads.

Fig. 101 is of white marble, and has the short stem nearly at a right angle with the bowl. The angles and bowl are rounded, and the latter is chiseled within. This is from Wayne County, and is two and three eighths inches high. Fig. 102 is a stemless pipe bowl of dark soapstone, one and seven eighths inches high. It is curved and polished, and the rim has deep curves between the two raised points. It is a rare form, and comes from the Seneca River.

Fig. 103 is a bird pipe of dark green slate, from the Oneida River. It is moderately thick, and there is a perforated projection in front, to which ornaments may have been attached. It has wings and feathers, a cockscomb, and an engraved collar or necklace, as well as a thick open bill. The form and work are modern. One much like this, but ruder, is in the Canadian collection at Toronto. This has a simpler crest, thicker bill, and less detail than the New York pipe, and is but four and one fourth inches high, while the former is seven and one half inches.

Fig. 104 is a flat turtle pipe of yellowish grey stone from the Oswego River. It is two and one half by two and one fourth inches across, and but seven eighths of an inch high. This form occurs elsewhere, both in New York and Canada, and might be called a platform pipe. Fig. 105 is a very rude and low soapstone platform pipe, from the east end of Oneida Lake. It is one and three quarters by one and one half inches. Fig. 106 is a black marble pipe from the Seneca River. It is perfectly plain, but otherwise much like some already described. From tip to tip it is three and three eighths inches.

Fig. 107 is almost globular, and of grey quartzite. There is a groove around the center, and radiating cuts at the top. The height is two and one quarter inches, and it comes from Van Buren. Fig. 108 is a small black and broken pipe from Canandaigua, much contracted between the low bowl and swollen base. It is not quite one and one half inches high, and is from a recent site. It seems an imitation of some European forms. Fig. 109 is a long platform pipe, perhaps made by the Cherokees. The platform is perforated at the

extreme front, and the bowl is angular. It is five and one eighth inches long and two and one quarter high, and comes from the east end of Oneida Lake. Fig. 110 resembles modern western forms, but is of grey stone. It tapers to a curving point in front, and is three and one half long by two inches high.

Fig. 111 is a double stone pipe, found near Nichols Pond in Madison County, but probably having no relations to it. It is formed like a keg, with a bowl at each end, and stem holes sloping different ways. It is of brown sandstone, two inches high by one and three fourths thick. Fig. 112 is of sienna colored marble, elliptic in longitudinal section, contracted and grooved a third of the way from the top. The base has a projection with a perforation. Height two and one quarter inches. It is a recent form, and comes from Brewerton. A similar one, contracted but not grooved, comes from Cross Lake. It has a large orifice, a basal perforation, and is two and three fourths inches high.

Fig. 113 is a double faced bird pipe, two and one half inches deep, from Monroe County. It is a recent form, with basal fluting and projection. Fig. 114 is a dark stone pipe from Pompey. Like all with this platform and basal projection, it is a recent form. The height is three and one half inches. Fig. 115 is a very different style of platform pipe, from the Seneca River. The extreme length is three and three fourths inches, and the stem hole is at the short end. It is quite thin, and is made of a crystalline stone.

Fig. 116 is from the Seneca Castle of 1779 at Geneva, and is sometimes called the bottle stopper pattern. It has a pointed and perforated base, and is two and three fourths high by one and one fourth inches thick. It is a recent form, of course. Another much like it, comes from the same place. Another is from Canoga, the birth place of Red Jacket, and is a little smaller. Another is from Onondaga Lake, and many more might be mentioned, all with perforated bases, which is a modern feature. It is one of the most frequent and recent of our stone pipes.

Fig. 117 is another bird pipe, similar to Fig. 103, and a rare form. It seems to have been made by the same hand, and was found on the Seneca River. The same style of work appears in some Ohio

pipes, and in one figured by Dr. Rau from New York. This pipe is of green slate, and not thick, and has a perforated projection in front, as well as lines and grooves for feathers. The extreme length is three and three fourths inches.

Fig. 118 is a steatite pipe with a projecting rim on either side ot the stem. The same form occurs in clay in Cayuga, where this feature is quite common on clay pipes of various forms. This was found with these, and is a rare form in any material. Except for the flanges it is a tapering cylinder, slightly bent. It is three and three quarters long by one inch in diameter at the top of the bowl.

Fig. 119 is an ovoid pipe from Onondaga, made of grey limestone, and two inches high. The form is rather rare in New York, and may be called a southern form. Fig. 120 is a slender black pipe from Seneca Falls, two and three fourths inches long, and having the stem at a very broad angle with the bowl. Fig. 151 is a straight and somewhat flattened pipe of dark green soapstone. Though others approach this it may be considered unique. It is from Brewerton, and is three inches long, by one and one eighth thick. Fig. 152 is similar but not so straight, and has flanges on each side below the bowl, which is more distinct than in the last. It belongs to the Onondaga Historical Association, and probably is from that county. It is of green sandstone, and is three and three quarters inches long. Such straight pipes are everywhere rare. Another of green soapstone comes from the east shore of Cayuga Lake, and this has a narrow projection on one side below the bowl.

Fig. 153 is a common form in clay, but rare in stone, being often called the trumpet form. It has a curved stem, broadening into the circular bowl, and the latter has moldings and beaded grooves. It is three and five eighths inches long, and was found west of Cross Lake. Its interest is in the material.

Platform pipes sometimes have a slight ornamentation of a simple kind. A fine one from Cross Lake has an oblong bowl at one end, and lines on the top of the platform. The stem hole, as in some other cases, is at the short end of the platform, leaving the longer projection beyond the bowl. The height is one and seven eighths inches. One of brown marble has moldings around the

top, and a zigzag ornament on the narrow edge of the stem. The platform of this comes to a point at the short end. The height is two and one-eighth inches. Another of soapstone from the east end of Oneida Lake, has the bowl close to the end of the long platform. It is three and one half long by one and one half inches high. There are many varieties of the platform pipe, and they reach the Hudson at least.

One simple but graceful pipe is from Jefferson County, and bears some resemblance to some before figured, but is more slender. It contracts below the top of the circular bowl, and then gradually expands toward the rounded base. It is less than two inches high. Most of the stone pipes from that county are recent forms, the early inhabitants, probably the ancestors of the Onondagas, having used those of clay. Of these there are fine examples. One curious pipe of mottled green soapstone, comes from that county. The raised end of the bowl, which is at the back as usual in this form, is divided into two broad horns, on each of which is a human face of modern type. It was probably made in the seventeenth century. Each projection is divided into two concentric horns above the face, terminating in a point. In these respects it is unique.

TUBES

Five classes of tubes are enumerated by Mr. Fowke, in the Reports of the Bureau of Ethnology, four of which are represented in New York. To these may be added here those with four flattened sides, which do not essentially differ from the cylindric forms; and those with an expanding end, generally almost closed. The use of all these articles is conjectural, and may not have been always the same. One well supported theory is that they were used in sucking blood when bleeding was resorted to, or in injecting the smoke of medicinal plants. In California they have bone mouth pieces, and are usually classed as pipes. Schoolcraft gave the first account of these in 1843, and those he examined from a Grave Creek mound are like those found in New York and on the east shore of Lake Champlain. His account is not readily accessible, and may therefore be quoted.

'Several polished tubes of stone have been found in one of the lesser mounds, the use of which is not apparent. One of these, now on my table, is 12 inches long, one and one fourth wide at one end, and one and one half at the other. It is made of a compact lead blue steatite, mottled, and has been constructed by boring, in the manner of a gun barrel. This boring is continued to within about three eighths of an inch of the larger end, through which but a small aperture is left. If this small aperture be looked through, objects at a distance are more clearly seen. Whether it had this telescopic use or others, the degree of art evinced in its construction is far from rude. By inserting a wooden rod and valve this tube would be converted into a powerful siphon or syringe.'

For a time these were called telescopic tubes, and it will be observed that the description is like that of those found at Otisco Lake, Palatine Bridge and Lake Champlain, which differ much from the ordinary stone tubes. Those found on the east shore of Lake Champlain, by Prof. George H. Perkins, were from seven to 13 inches long, the perforation being about an inch in general diameter, contracting to half an inch at one end, which had a small perforation, closed by a stone plug. Others have been found on that lake, but these plugs are not elsewhere reported.

The material of tubes in general is soft, and often ornamental. Some are gouged out, and some drilled, and the outline varies greatly. The long ones, with one end expanded, and with a small central perforation in this, connecting it with the usually uniform perforation just within, are of quite soft material. Those from Otisco Lake were either filled or in contact with red paint. This class of tubes embraces those much longer than the ordinary forms, and they are more slender than the long ones of California. Some forms are drilled from both ends, and this may be the case with the larger part. They do not seem to reach the Atlantic coast, but one of oolitic limestone was found at Deming's Point, Dutchess County, which was broken at one end. It is now five and three fourths inches long, an inch in diameter at the perfect end, and one and one eighth at the other.

While it is conceded that the California tubes were pipes, their use in the East is not yet determined. They were made and used by early nations, not the later comers, probably, among whom, how-

ever, bone tubes may have supplied their place. Small bone tubes are found on Iroquois sites, but may have been used for ornaments. Among the Onondagas long tubular bone or cane whistles were employed in medicine making, even within a few years.

Fig. 122 is a tube of dark green striped slate, generally rectangular in section, but with the broader sides somewhat convex and the narrower concave. It comes from the Oswego River, and is of a slightly tapering form. The perforation is usually smaller at one end than the other, and in this case is three eighths by nine sixteenths of an inch. It is three and one half long by one and one fourth inches wide.

Fig. 123 is a cylindric tube of grey striped slate from Camillus, five and five eighths inches long by one inch in diameter. This is the usual form. Fig. 124 is of light olive green slate, a little over three and one fourth inches long, and comes from the town of Van Buren. The orifice is half an inch at one end, and five eighths of an inch in diameter at the other. It is not quite elliptic in section, being flattened on one side. This was found in 1846, and is a rare form. Fig. 125 is a cylindric, tapering tube, of a very beautiful striped green slate, with interrupted bands. It is seven inches long, and was found in Palermo, Oswego County. It is thickest toward one end.

Fig. 128 is a long sandstone tube, apparently, but Mr. S. L. Frey thought it might be steatite on microscopic examination. It is one of several found in graves at Palatine Bridge. The orifice at the small end is over five eighths of an inch wide, and the diameter of the tube there is one inch. The general diameter is about one and one eighth inches, and the length nine and one half, being reduced in the illustration. The perforation is quite uniform until near the broad end, where the outside of the tube suddenly expands, and has a small central perforation in the end. Another is longer. A similar one, belonging to Mr. A. G. Richmond, is 10 inches long, but a little narrower than the one described. It was found in the same cemetery. The graves were quite remarkable, and contained other relics. Fig. 129 is one of a different form, found at the same place, but not in the same grave. The outline is undulating, much like

some wooden handles, and the perforation gradually contracts, showing an important difference in the mode of drilling. The size is four and one half long by one and one fourth inches in diameter. The illustration is reduced.

Fig. 130 is a large and angular tube of soapstone, much curved, and with a raised band in the central part. It is eight and one half inches long, and is from Allegany County. The same form occurs in Tennessee, but is rare.

Three of a greenish white and soft slate were found in a grave by Otisco Lake some years since. They are in fragments, all of which were not saved, and are of the same general character as the first described from Palatine Bridge. The expanded end is one and three eighths inches in diameter, and the general thickness is one and one eighth inches, thus closely corresponding in size. Full accounts of those at Palatine Bridge and Swanton have been published in the *American Naturalist*, and some particulars regarding the Otisco tubes may be of interest. They were unearthed many years ago, in digging foundations for a barn on the east side of Otisco Lake, and were thrown into a soap box with other things, some of which were taken away from time to time. Two skeletons lay side by side with them, well preserved; also arrow points, and lumps of red and white paint. They were about two feet under ground, and the skeletons had their heads to the west. Among the fragments left are two perforated end pieces, and the size of other pieces indicates at least three tubes. Being broken the circular lines of the boring within are plainly seen, and the perforation rapidly contracts near the small hole by a series of four or five circular ridges. Some of the fragments are stained within and without with red paint, but probably did not contain this. The graves were on Mr. Van Benthuysen's farm north of Amber.

One of reddish grey sandstone, found east of the Seneca River in 1841, and therefore one of the earliest brought to light, was described by the owner as a stone faucet, which it resembles. It is tapering, and thickest near the center. The length is six and one eighth inches, and the diameter one and one half in the thickest part. The orifice is three fourths and five eighths of an inch.

Occasionally one is found unfinished, like a regularly cylindric one from Jefferson County, which is six and three fourths inches long, and not polished. The hole is one and three fourths inches deep, and seems to have been drilled with flint, as it tapers to a point. A cylindric one of striped olive slate is from Onondaga, and is eight and three eighths long by one and one eighth inches thick. Another of green striped slate is from Cayuga County, one side being flat and the rest convex. The orifice is unusually small; not over a quarter of an inch. It is three inches long by one and one half thick. A curved tube comes from Chaumont, and is three and one half long by one and one fourth inches broad. Other tubes have also been found in Jefferson County.

One from Saratoga is three and one half by two and one half inches, an unusual proportion here. A cylindric one of striped slate from Brewerton, is four and three fourths by one and one half inches. A very long one of green striped slate, from near Albany, is 11 inches long, if correctly reported. This would be an unusual size in this material.

Some tubes are very small, and a cylindric one of striped olive slate, from Seneca Lake is two and one half inches by less than one. An unfinished tube from Cross Lake is four by one and five eighths inches. The boring is uniform to the depth of one and five eighths inches, showing circular grooves. It is of picked greenstone.

Out of 73 tubes Mr. Douglass had none from New York.

BAYONET SLATES

For want of a better this term is applied to a small class of rare implements, probably of a ceremonial kind. Very few have been found. They are slender, and nearly or quite parallel sided and triangular in section. One found in Vermont is seven and one eighth by one and one eighth inches, and has no shouldered base. Another has been found in Canada closely resembling this in form and size. Two others come from Onondaga County, and are probably the finest known, as they seem to complete the list.

Fig. 131 is a very fine example of this rare article, and the largest yet found. It is reduced for illustration, but is eight and seven

eighths inches long by seven eighths of an inch wide. The broad surface is flat, the other two forming a ridge at their junction, making the implement triangular in section. There is a slight tapering toward the point, which is formed by a quick curving of the edges. The base is a little contracted, and depressed on the upper side, with slight notches for attaching it to a handle. The material is bluish striped slate, and it was found near Brewerton on the Oneida River.

Fig. 132 is also reduced, and is of a similar article a little wider and much shorter; the length being four and seven eighths inches. The base is shorter and more contracted than the last, and the point not as quickly curved. This is also of striped slate. It was found near Brewerton, and also on low land.

The two just described came from low ground, and are somewhat discolored in this way, specially on one surface. They are as finely polished as other implements of striped slate, and in excellent preservation. No signs of use appear upon them, and they may have had little more than an ornamental character.

AMULETS

Bird and bar amulets are very rare south of Ohio, nor are the latter frequent anywhere. One of the former has been found in Virginia, one in Pennsylvania, and one in New Jersey. The latter one has projecting ears, and is four and one half inches long. They reach Wisconsin on the west, and occur sparingly in New England.

The theories about their use seem fanciful, as some certainly are. Two writers assert that they were worn by married or pregnant women only, and many have accepted this statement. Others think they were worn by conjurers, or fixed on the prows of canoes. It is enough to say that some of the perforations are not adapted to any of these uses. It seems better to class them with the war and prey or hunting gods of the Zunis, some of which they resemble. In that case, the holes, of whatever kind, would have given a firm hold to the thongs which bound the arrows to the amulet, a matter of importance in an irregular figure.

These perforations form the most important feature. The amulet may be but a simple bar, but at each end of the base is a sloping hole, bored from the end and base and meeting. To this necessary feature may be added a simple head or tail, and there may also be projecting ears. None of these are essential. They are but appropriate or tasteful accessories.

Two notable collections contain a large number of amulets. In the Canadian collection at Toronto there are about fifty bird amulets from the province of Ontario, and many of these are much depressed. The longest is six and three eighths inches. Besides these there is a score of bar amulets, a very much rarer form. The longest is six and one quarter inches. They are mostly of striped slate.

The collection of Mr. A. E. Douglass is larger, having 70 bird amulets; 35 of which are from Ohio, and 16 from New York. One of the latter, from near Auburn, has a turtle-shaped head. His collection contains the unusually large number of 38 bar amulets, 22 of which are from Ohio, and but one from New York. The latter seem quite rare here, not more than half a dozen having come before us. Bird amulets are much more frequent, upwards of 50 having been shown us in various places, besides those mentioned above.

They were variable in material as well as form, although most commonly made of striped slate. Perhaps full half have projecting ears, when of the bird form. In the wider forms, usually of harder materials, there are often cross bars on the under side, in which the perforations are made. Occasionally these are not entirely enclosed, yet are without signs of breakage. This seems to prove that these were not intended as a means of attaching them to any larger object, on which they would rest, but rather for fastening articles upon them, as in the Zuni amulets already mentioned, and which were illustrated by Mr. Frank H. Cushing, in the second Report of the Bureau of Ethnology. On comparison a general resemblance to these will be seen, and in a few cases it is quite striking. That they were used in this way, rather than in those suggested by others, is a reasonable conclusion which gains strength with fuller study.

As a class they belong to the St. Lawrence basin and the region of the great lakes, but seem most abundant north and south of Lake Erie. In New York they are most frequent for a few miles south of Lake Ontario, specially near the Seneca River and the larger lakes connected with it. They are found on Lake Champlain also, several coming from the vicinity of Plattsburg. Two came from Washington County, one of which has an expanded body and prominent ears, and is made of slate. Usually this material is confined to the narrower forms. This one is four inches long and one and one half high. The other, of the same material, is of a different form, and shorter and higher.. The dimensions are three and one half by two inches.

Fig. 135 is a remarkably fine bird amulet of green striped slate, the longest we have seen from New York, but reduced in the illustration. It is nine and seven eighths inches from tip to tip, and of moderate height and thickness. It was found at Dexter, near the mouth of the Black River, and although in three pieces was not otherwise defaced. The back is sharp, and it has projecting ears and a long neck. The head ends squarely. Another, from the same county, is also large, being eight and five eighths inches long by two high. It has no projecting ears.

Fig. 136 is from Dresden, on Seneca Lake, and is of green striped slate. The ears are unusually small. It is a fine article, and is three and one half long by one and one half inches high. Fig. 137 is of the same material, but is much depressed. The sloping tail expands to three inches in width. This is from Jefferson County, and the length is six and one eighth inches.

Fig. 139 is also of green striped slate, from the Seneca River, and is three and one fourth inches in length. There are no ears, but along the edges are 91 notches. This feature often appears, but not to this extent. Fig. 140 is of trap rock, and comes from Clinton County. It is rude, depressed, and has small ears. The general form is quite straight, but the tail is slightly raised. It is more suggestive of the Zuni amulets than most forms. The dimensions are six and seven eighths long by one and one half inches high.

Fig. 141 is a broad form of mottled stone, three and three eighths long by one and three fourths inches high. It comes from Newark

Valley, Tioga County. There are small projecting ears and the tail comes to a point, as in some others of this general form and material. Two views are given of it. This form is highly polished, and the basal perforations are not always completely enclosed. They have also, as a rule, a slight transverse ridge, in which the perforation is made.

Fig. 142 is from Elbridge, and of green striped slate. It is quite depressed, and the tail is but one inch high, the length being four and one half inches. The large ears have but a small projection, and the general form is narrow. Fig. 143 is from Cayuga County, and is of the same material. It is somewhat depressed, and has a very long and pointed head. The dimensions are five by one and three fourths inches high. Many from that vicinity are depressed.

Fig. 144 comes from near the Seneca River, and is of the same slate. It is three and three eighths long by one and three eighths inches high, and has no ears. Fig. 145 is from Brewerton, where many have been found. It is quite thick and heavy, making a strong contrast with the last. The material is a grey striped slate, and the ears are small. It is five and five eighths inches long.

Fig. 146 is a very curious and fine bird amulet from the Seneca River, four and one half inches long by one and three fourths wide, made of a mottled dark stone, grey and yellow, hard and highly polished. The ears project to an unusual extent, and the forward perforation is not entirely closed. It closely resembles one from Grand Rapids, Michigan, in form and material, but has a more expanded tail. In fact it may be considered the finest example of this class of amulets yet found.

A few others may be briefly described, without illustrations. One of green striped slate, from Baldwinsville, has no ears, and is four and one fourth long by one and three fourths inches high, which is about the average size. The tail varies much in angle and height, in the several specimens, and the head is as variable in form and length.

One of brown striped slate, found a few miles south of the Seneca River, has no ears and is much depressed. It is five inches long and two and one fourth high. Another of brown slate, from Cayuga

County, and which is broken, has a lateral perforation, a frequent feature for a secondary use of ornamental stones, allowing them to be suspended as decorations. The edges are also notched, a frequent feature of amulets, perhaps as a record. The remaining part of this is three inches long. One from the Onondaga Reservation was worn as a decoration by an Indian girl, being suspended by a string passed through the secondary lateral perforation. This amulet is of green slate, and has been broken, having lost the bill or nose. It is still four and one fourth inches long by one and seven eighths high.

A fine one from the Oswego River, of green striped slate, is of unusual form. The ears are elliptic, slightly raised but not stemmed, and there is a shallow groove in each. It is three and one fourth long by one and one fourth inches high. Another, of the same slate, was found south of the Seneca River, and has projecting ears. This is four and one half long by one and one half inches high. Still another, of this material, is from St. Lawrence County, and is one and three fourths inches high by three and one fourth long. It is quite high for its length, and the tail is upright, which is not a rare feature. One of light green slate, from the Seneca River, is quite thin, and had small projecting ears, one of which has disappeared. The tail is low, and the amulet is five inches long by one and three fourths high. Many broken amulets might be described, and some have interesting peculiarities. One of grey slate, from Cayuga County, has a lateral perforation and an unusually long neck. A water worn one, from the beach of Cayuga Lake, has a rounded tail, and a groove across the base.

It will be seen that the bar amulets are few in comparison with the others, but they were apparently all used in the same way. All have the terminal basal perforations, and usually they are slightly raised in the center and at the ends. Fig. 147 represents the typical form. This is of dark green striped slate, and was found on the Seneca River. This is five and seven eighths inches long and three fourths of an inch wide and high. It is slightly elevated and thickened at the center and ends. Of course there is nothing specially

ornamental in this, but it might readily be used as the Zuni amulets were.

Another, almost exactly like this, was found at Onondaga Lake, but is a little longer. Still another of striped slate, very uniform in thickness throughout, was found on the Oneida River in 1879. It had lain for centuries in low land, and was much discolored. The length was five and one fourth inches, and the width and depth one inch each. One from Wayne County is of dark green slate, and has small notches or tally marks along the edges. It has a flattened top, which may have been a curving ridge at first, and is five and one eighth inches long by three quarters of an inch high. A broken one, of the same material, comes from Brewerton, and another, of brownish slate, was found near the Willard Asylum on Seneca Lake. This is four inches long.

BOAT STONES

Mr. Fowke classes the boat stones as a division of the banner stones, sometimes calling them gorgets; neither of which do they much resemble. They are not always perforated, though this may have been the ultimate intention. When this has been done there are usually two holes, bored from the same side. Banner stones have commonly but one hole, which is large, central, and quite uniform. Gorgets may have several, and each one is usually drilled from both sides. The banner stones might have been used on a staff, whether they were or not. No such use could have been made either of boat stone or gorget. Very often, however, fine examples of the former are not perforated, and have little in common with the other implements mentioned.

Few true boat stones, if by this is to be understood those which have been excavated, are to be found in New York. The excavation, however, may be merely a device to make the stone lighter, rather than an essential feature. If this is allowed, as seems reasonable, many might be placed under this head.

Fig. 154 is one of these, four and one eighth inches long, and seven eighths of an inch high. It is a little over an inch in width, and a lateral section gives a long triangle, the deepest part being near one end. Before and behind this are perforations from top

to bottom, of unequal diameter, but each broadest at the base. The material is striped slate, and it was found on the east side of Cayuga Lake.

Fig. 155 has a slightly curved base, with a convex sweep; the upper surface having a much greater convexity. A groove is carried through the base, hollowing it as in the true boat stones. It is of green slate, striped, and has two holes; these, as in other cases, being drilled from the lower side, and are broad on that surface and small above. This was found on the east side of Onondaga Lake, and is three and three fourths inches long, one and one eighth wide, and three fourths of an inch high. The outline of this and the last, from above, is very nearly a parallelogram.

Fig. 156 has a broad broken end, which has been smoothed, and this is perforated somewhat like the amulets; a terminal hole intersecting that bored from base to top. The other end resembles the tails of bird amulets, but is unperforated. Another hole, however, goes from base to ridge, being intersected by a lateral basal groove. Both this groove and the terminal perforation, of course, are secondary. On what was the central apex is a small nipple, frequently found in this class of articles. The perfect end has slight notches, and the material is brown slate. The present length is three and one eighth inches, and it is one and one eighth in height. This interesting example of original design and secondary work is from the Oswego River.

Fig. 157 is of green striped slate, five and one half inches long and one and three eighths high. It was found north of Cross Lake, and has the two customary perforations, one before and one behind the central and prominent nipple. It is a fine example of this form. Some smaller Ohio specimens have quite a pyramidal outline, and the nipple is like a small ball.

Fig. 158 is of the same slate, and somewhat like a low pyramid, but the opposite sides do not quite meet at the top. It is four and one fourth inches long, one and one half wide, and one and one fourth high. This has neither perforation nor excavation, and is from the Seneca River.

Fig. 165 may be simply a long perforated sinker, of light greenish slate, but the terminal perforations suggest both the bar amulets and the perforated boat stones, to neither of which does it belong. There is a slight groove toward one end, and depressions around the holes. The general section would be three-sided. It comes from the Seneca River.

Fig. 214 is unperforated, nor has it a nipple. It expands greatly in the center, where it is over one and one fourth inches wide, while the terminal widths are much less than an inch. It is five and one eighth inches long, and seven eighths of an inch high in the center. The material is brown slate, and it comes from Hannibal. An unfinished one of granite, almost pyramidal and six and one half inches long, is from Oswego Falls. Several come from Cayuga County, and one from Troy has two perforations, and is five and one eighth inches long and one inch high. A fine one of dark olive slate, with nearly straight base and convex upper surface, comes from Canajoharie. There are two perforations from the base, which is also grooved. It is five and one eighth inches long, one and one fourth high, and one and one eighth wide. One of slate, from Tioga County, has a straight base and a rounded upper surface. It is three and one fourth inches long, and has two perforations, the specific number.

True boat stones occur throughout the northern States, and many good examples are found in Ohio. New York has probably as many forms as any. They are found along Lake Champlain, and at several places on the Hudson River, as well as in the localities already mentioned.

CUPS AND MORTARS

Small cups are occasionally found, probably used for holding paint, and usually having one side elevated. Mortars are often but depressions in bowlders or rocks, and these are found in all parts of New York, though most frequent near tidal waters. Some of those thus classed, however, are simply hollows made in sharpening tools. Of this character is one on Indian Hill, the Onondaga site of 1654. Several polished depressions will be found in a large bowlder there. Mortars, however, were often portable. One from

near Syracuse is of calcareous tufa, seven inches in outside depth, and four and one half inside. The upper diameters are 11 and $11\frac{1}{2}$, with a diameter of eight inches at the bottom. This has been called a mortar, but is properly a vessel of another kind. One from Kendaia is a nearly circular pebble, seven and one half inches across, and excavated on both sides. A fine circular one is from Pompey Center, of limestone, and much like the last. It is nine inches in diameter, and the depression is six inches across. Many of these might be described.

Fig. 159 is a beautiful cup of dark bluish green striped slate, two and three fourths inches across. It was found in Hannibal in 1875, and is unique here, but one has since been added to the Toronto collection, closely resembling this in every way. The form is circular, and the shallow bowl is neatly curved to a point at the base. These two examples add to the other proofs of the close relations of New York and Canada in prehistoric times.

Most cups are of ruder form, and they are rarely symmetrical. Fig. 160 is one of these, and is of soapstone, with one side raised. It is two and five eighths inches across the long diameter, and comes from the Oneida River, with one of similar form. Fig. 163 is a small one found in or near an earthwork in Elbridge, and made of brown sandstone. It is one and one fourth inches wide, and one side is deeper than the other. A paint dish or bowl, four and one fourth inches wide and two deep, comes from the Mohawk River. A small stone ball was in it. There are other examples, but of no special importance.

DOUBLE-EDGED SLATE KNIVES

A class of polished slate knives in New York and part of Canada, has long had the local name of slate arrows, and these are but little known to archæologists in general. They closely resemble but are not generally identical with some of the slate knives of the Point Barrow Eskimo, figured and described in the ninth Report of the Bureau of Ethnology. Those figured in that volume have no barbs, and these are a common but not invariable feature of these New York knives. The grinding and provisions for hafting are identical.

There are suggestive similarities between several Iroquois articles

and those of the Eskimo, but these slate knives were apparently used here long before the Iroquois entered New York. The half circular slate knives of Canada, New York and the Eastern States, also raise the question of early visits of the Eskimo, and the probability of these is strengthened by the recent finding of articles made of walrus tusks, south of Lake Ontario. They occur also in Canada, and near the St. Lawrence. Without discussing this question at length, it may suffice to say that these two forms of knives are in present use among the Eskimo, and that that people lived on the north shores of the Gulf of St. Lawrence 300 years ago, whence, at a still earlier day, it would have been easy for them to make hunting excursions into New York by water. Certain it is that south of New York one of these articles has never been found, and the other but rarely.

In some parts of Canada the knives now to be considered are about as common as in New York, being most abundant on both sides of Lake Ontario. They have not been reported east of Lake Champlain, except in its immediate vicinity, with the exception of one in Maine, nor do they reach more than half way southward to the Pennsylvania line. In fact here they are rarely found far away from the larger lakes and streams tributary to the St. Lawrence.

Fig. 161 is a dark grey slate knife of this kind, and one of a frequent form, being shouldered but having no barbs. There are slight notches on either side of the tang. It is two and three eighths inches long, and not quite one and one fourth wide. Fig. 164 is another of grey slate, two and one fourth long by one and one fourth inches wide. This is broadly shouldered, and approaches the barbed form. The base is of unusual dimensions, being half the length. Both of these are from the Seneca River.

Fig. 166 is very long, and with nearly parallel sides. The base is broken, but it is still five and five eighths inches long by one and one fourth wide. It has barbs and distinct notches, and is reported from Chenango County, an unusual location. Fig. 167 is of grey slate, with long barbs and very deep notches, which are like sharp teeth. It is three and three fourths inches long and one and three

eighths broad. From the Seneca River. Fig. 168 is a small and deeply notched knife, of unusual form, one and five eighths inches long. It is of dark grey slate, and was found at Brewerton. Fig. 169 is of dark slate, and is from the Oneida River. In its present form it closely resembles some of the Eskimo knives, but it probably once had barbs which have been cut away. It is two and one half inches long by one broad. Occasionally one seems to have been broken and recut, leaving it unsymmetrical but strikingly like some recent Eskimo knives.

Fig. 170 is of red slate, shouldered, short and very broad. It is from Jefferson County, and one and five eighths inches long by one and one eighth wide. The notches are deep. Those of red slate are often quite broad. They occur mostly on Lake Champlain, but some are found south of Lake Ontario.

Fig. 171 is of bluish slate, from the Seneca River, and has barbs. It is two and three eighths inches long and one and one fourth wide. This is a frequent form. Fig. 172 is of dark slate, from Chittenango Creek, near Oneida Lake, and is three by one and three eighths inches. Instead of coming to a more or less defined medial ridge, it is sharply beveled from a plane surface to the edges. It is shouldered, and the base has no lateral notches. Fig. 173 is the smallest yet found, and is of grey slate, and one and one fourth inches long by a little over half an inch broad. It is shouldered and rather rude. This was found at Onondaga Lake. Fig. 174 is omitted.

Fig. 175 is of dark slate, somewhat barbed, and conspicuously notched on the edges of the base. It is ground from the center to the edges, like most others, and is three and three fourths inches long by one and three eighths wide. This is from the Seneca River. Fig. 176 is the handsomest yet found, and is from an island in the Oneida River at Brewerton, where broken harpoons, as well as perfect ones, have been abundant. It is of grey slate, shouldered and thin, finely polished, and with an unusually slender base and deep notches. The base is finely finished and rounded. This fine knife is two and seven eighths inches long by one and one eighth wide.

But a few typical specimens are figured, but these knives vary much in proportions and details. The barbs are usually formed by cutting a groove between the cutting edge and tang, and the notches may be simply cuts or half circular grooves. The surface is usually ground all over, and all is polished except the flattened tang, which is often slightly roughened by a coarser grinding. In Eskimo knives this is inserted in a handle, and the New York specimens are usually beveled for this purpose. A few others may be mentioned.

One of greenish slate, from Baldwinsville, is one and three fourths long by one and one fourth inches wide, and is barbed and notched. A similar one is of the same dimensions. A slender one of dark slate is barbed, but has the base broken. It is four and three fourths inches long by one and one half wide. A curious one of red slate is very broad. It is broken, but was originally three and one fourth long by two and one fourth inches broad. It may have been a little longer, but the edges have more than the usual convex sweep. All these are from the same place.

Another broken one, from the same locality, is of dark slate, shouldered, and without lateral notches. The present size is three and one fourth by one and one half inches, and it was once a fine implement. One which is barbed and has a convex edge, is flat in the center, instead of having the usual ridge. It is two and three fourths by one and one half inches. Another fine one of grey slate, also from the Seneca River, has a very sharp point, and is seven and one half by one and one fourth inches, an unusual size.

A small one of grey slate, from the Oswego River, is barbed, and has both blade and base very tapering. It is two inches by one. A long one of grey slate, from Baldwinsville, is also barbed, and is four and one half by one and three eighths inches. A handsome one of brown slate is from the same place, and is shouldered. The surface is rounded and not distinctly ridged. It is three and one eighth inches long by one and one fourth broad.

A shouldered one of black slate, from the Oswego River, is three and one fourth inches long by one and one fourth wide. One from Onondaga Lake is barbed and has the sharp end neatly

rounded, instead of coming to a point. This part differs little from the rest of the work, but if it was the original design it is certainly unique. It was probably repointed at an early or recent day. It is of dark slate, two and one half by one and one fourth inches. One of dark slate, from the Seneca River, has very deep notches, and is one and three fourths long by one and one eighth inches wide. Another of green slate, from the same river; has the same features, and is three by one and three eighths inches. Quite a number of grey slate come from the Oswego River. A fine one of this material, from the Seneca River, is shouldered, but has no grooves or lateral notches. It is three and one eighth inches long by one and one fourth wide, which is about the average size. Another of red slate is from the same place, and is broken, but is two and one eighth inches wide, and was proportionately long; probably about six inches. The base is short and the notches deep. This is barbed.

A barbed one, with a very long stem, comes from Oswego Falls. Another, of dark slate and shouldered, is from Chittenango Creek, and is three by one and five eighths inches. Another long-stemmed knife of grey slate is from Brewerton, and is two and three eighths by one and three eighths inches. The barbs are long and the notches distant, A large black one comes from Cayuga County, and several from Jefferson. These are not far from three inches in length. A large black one is from Rome, where others have been found. A broken one of black slate is from Kendaia, east of Seneca Lake, the extreme southern limit of these articles thus far. The width is one and three eighths and the present length three inches. Several come from that lake, as would be natural from its connection with the Oswego river. A fine barbed one of brown slate, having deep notches, is from Seneca County, and is three and one eighth by one and one fourth inches. Another black and barbed one, which has lost its base, is from the same vicinity. The present size is four and one fourth by one and five eighths inches.

One from near Holland Patent now represents the eastern range of these in the interior of New York. It is barbed, of grey slate and is four and one half by one and five eighths inches. Another of grey slate, from Brewerton, has unusually long and prominent barbs, as

well as deep notches. It is two and three eighths by one and three eighths inches. Another from that vicinity, of black slate, is smooth and thick. It is shouldered but there are suggestions of barbs, and the base is nearly half the length. It is three and one eighth inches long by one and one half wide. In all about 100 have been figured and described in New York, and a smaller number in Canada. Of New York specimens two thirds come from a territory of forty miles square, and always near water. This is significant of their use.

THE WOMAN'S KNIFE

Much better known than the double edged slate knife is the semi-circular one, known as the Ulü, or woman's knife of the Eskimo, and still in use by that people. In the interesting examples figured by Prof. Otis T. Mason and others, will be found those of metal and slate, which closely resemble those of stone found in our fields, shown also with handles attached. Ours, however, are never perforated, nor is the curved outline interrupted before reaching the back, thus answering to but a division of these interesting implements. Dr. Abbott has well said, 'As these semi-lunar knives are more abundant in New England than in the Middle States, and do not appear to have been in use among the southern coast tribes, it is probable that the pattern is derived from the Eskimo, with whom the Northern Algonkins were frequently in contact.' Dr. Rau endorsed this view.

Since these eminent scientists published this opinion many of these implements have been found in New York, perhaps more than in all the New England States, and the features of their distribution point to their use by northern visitors, rather than by settled inhabitants. They are far from rare on both sides of Lake Ontario, but most frequent toward the eastern end, the part most accessible to the Eskimo. Very rarely they have been found in New Jersey and Pennsylvania, and are oftenest near fishing resorts. They were unknown to the Iroquois.

They are all essentially of the same form, the principal difference being in having a simple or a thickened back, so that a very few

figures will fairly illustrate this class of implements, though some others may be described.

Fig. 177 is of a slaty sandstone, and has an unusually deep thickened back, the blade being quite thin. The edge has been broken, and this and the grinding required to keep it sharp, have interfered with the perfect curve. It was found west of Cross Lake, and is two and one fourth inches deep by two and seven eighths wide. These thickened backs are comparatively rare. Fig. 178 is quite unique, being of a black and very hard slate, which is very thick in comparison with others. The ends have been broken, and the back is rounded. It comes from the Seneca River, and its present size is three inches wide by one and one eighth deep.

Fig. 179 has lost about a third of its width which was originally five and one half inches, with a depth of two inches. It is of brown sandstone, with a deep and thick back. This is from the Seneca River. Fig. 180 comes from near Oneida Lake, and has no thickening of the nearly straight back. It is of grey sandstone, and forms nearly a half circle, two and one fourth by six and one eighth inches. A few others may be described.

One from near the Seneca River is of thin red slate, with a simple back, and is nearly a true half circle, being two by five inches. It is quite sharp and symmetrical. Another, from the Oneida River, is also of red slate, two and one half by six inches. One of dark slate, from Camden, has a less convex edge and an irregular back. It is six and one half by two inches. One of red slate, from Oswego County, broken, and now three by five inches, seems to have been originally nine and one fourth by three and one fourth inches. Another, from the same county, and of the same material, has an irregular back, and is six inches wide by one and three quarters deep. A very fine one of red slate, found on the Oneida River, is perfect, and is six and seven eighths by three inches, with a thickness of a quarter of an inch.

Several come from near Lake Champlain. One of these, of mottled slate, is six and one half by two and one eighth inches. A perfect one of dark slate is six by two inches; and another, which has a thick back, is five inches wide by two and three fourths deep.

Many come from near Brewerton and Oneida Lake. One of these is of brown banded slate, and has an irregular back. It is slightly broken, and was originally six by two inches. Another is of brown sandstone, and has a simple back neatly rounded on both edges. It is a little over one and one fourth inches deep, but was originally seven and three eighths wide. One of grey sandstone is five and three fourths by two and one eighth inches. Another of green slate is a true half circle, being five by two and one half inches. It has a straight back, and a similar one has a thickened back. Another, from Oswego County, is made of grey slate and has a straight back. It is six inches wide by two and one eighth deep.

A very light drab slate knife was found a little east of Onondaga Lake, and is five and three eighths by one and one fourth inches. The back is quite irregular. Another, from the Seneca River, is six and one eighth by two and one half inches; and still another of red slate is five and one half by two inches. One from St. Lawrence County has a simple back, which is more convex than usual. It is seven and one half by two inches. A large and handsome one, of purple slate, is from Cayuga Lake, and is six and one fourth by two and one half inches.

Dr. Rau figured a very fine one, in his *Prehistoric Fishing*, from Newark Valley, in Tioga County, which is six and three fourths inches wide, and has a thick curving back. Two others in that work are from Pennsylvania and Massachusetts, and others are added from the Eskimo of Norton Sound in Alaska, one of which is a frequent New York form.

Although most of those mentioned have been found in a few localities, they probably have a much larger distribution, while it is also true that they become rarer as we proceed west and south. In but few instances is the sweep of the blade quite a half circle, and those with thick backs are less symmetrical than those without. Their purpose is evident, from their use by the present Eskimo, being identical with the Ulu or woman's knife. Whether that people actually reached New York will not be debated now, but the opinion of those who think the Northmen found them in New England nine

centuries ago, is certainly strengthened by these relics. At that time the interior of New York had no settled inhabitants, and the New England seaboard does not seem to have been reached by the Algonquins.

BANNER STONES

Dr. Abbott classed certain perforated ' relics as banner stones or ornamental stones, either used in the decoration of weapons or for suspension from the body, after the manner of breastplates.' He adds, ' Whatever may have been the manner of exhibiting such stone ornaments it is impossible to determine, but the fortunate possessor of such a specimen might well be proud of it. May it not be that such stones were the charms of the medicine men? Stones that were concealed from the general gaze of the crowd, and only brought to view with elaborate coverings on great occasions. They do not seem sufficiently abundant to be simply the ornaments of chiefs and warriors'.

All archæologists nearly have conceded that they were not intended for mere use, and an effort has been made to call them ceremonial objects. The good sense of the public is likely to prevail in retaining Dr. Abbott's name. They are peculiar to America, and are of early date although surface finds. They were unknown to the Iroquois, nor has their use been perpetuated by the later Indians; but they are much more abundant than Dr. Abbott supposed.

Mr. Fowke's treatment of banner stones is somewhat confused, but he sensibly retains Dr. Abbott's name, so much more definite than that of ceremonial objects. That they were suspended as ornaments for the body, however, seems in no way probable, while the central perforation gives force to the idea that they were placed on slender poles for badges of authority or use in ceremonies. At the same time they so commonly accompanied the owner on long journeys, that they may have had some superstitious use. They occur mostly east of the Mississippi or in its drainage.

They were not all drilled alike. Some New York specimens, unfinished, show a pointed spiral hole, such as might have been made by a flint drill. Others have a central core remaining, showing

that the drill was hollow. Dr. Rau thought that such an implement might have been made from the southern cane, now used for fishing-rods and pipe-stems, which varies greatly in size, and is hard enough for such a purpose. In any case, sand and water were employed, but the work was slow. The stone was picked into shape, a little polishing done, and this was followed by the drilling and general grinding and polishing.

Of the varieties usually described nearly all occur in New York, though sometimes in a fragmentary condition, and this is true of Canada also. They vary much in form, size and material, but are usually of some ornamental stone, quite frequently the striped slate. Out of 209 banner stones in Mr. Douglass' collection but five are from New York, where they are of frequent occurrence, but rarely on village sites. They are sometimes pick-shaped, like a broad double axe, heart and butterfly shaped, like reels, and sometimes make a double crescent with four points.

Fig. 184 is of light green slate, slightly banded, and is of an expanded double hatchet form, which might be called that of a butterfly. It was found not far from Three River Point. As in most of the others, the orifice is a little larger at one end than the other, and the average in this one is five eighths of an inch. The extreme width is four and three eighths inches, and it is two and three fourths deep.

Fig. 185 is a straight, pointed, and elliptical article of green striped slate from the Oneida River. It is here represented in profile, which is the narrow way, an unusual feature, and thus the perforation is made through the narrower central diameter. It is four inches long, one and one eighth wide, and three fourths of an inch deep. The material is fine. Fig. 186 is very different, generally circular, but a little angular. It is of green striped slate, and one side has been broken. The depth is four and one half, and the original width five and three eighths inches. A deep rectangular indentation meets the orifice above and below, thus shortening it; and it has the usual central expansion of the thinner forms. It comes from Onondaga Lake.

Fig. 187 is nearly elliptical, but the wings terminate in points. It has one deep indentation, like the last. It is of thin striped slate, thickened in the middle as usual, and the dimensions are five and one half in width by two and five eighths inches deep. This was found four feet below the surface by the outlet of Chautauqua Lake, above Jamestown.

Fig. 188 is also of striped slate, with an orifice averaging five eighths of an inch. It came from Camillus, and is of the butterfly form, but differs from most specimens in not having the wings in a plane. It is rather thick, and is four and five eighths wide by one and seven eighths inches deep. Those as heavy as this of course might have served some useful purpose, but they are not sharpened and show no marks of use. The perforation is larger than would be required for mere suspension, and it seems reasonable that a handle or staff was inserted in this. The difference in the terminal diameters of the orifice is usually an eighth of an inch.

Fig. 189 approaches a long heart shape, indented at each end, and with the customary central ridge. It is of olive green slate, and much narrower for its depth than usual, though many have this general form. The larger diameter of the orifice is seven sixteenths of an inch, and the stone is two and three fourths wide by four and one eighth inches deep. This and the next are from Brewerton. Fig. 191 is quite curious from its unsymmetrical form and unusual perforation, the latter being elliptical. The material is a beautiful green striped slate, showing a fault in the stone, a not infrequent feature. This is quite sharp near the perforated end, and the outline each way is not unlike some forms of broad celts. The greatest diameter is two and five eighths inches, and that of the orifice eleven sixteenths of an inch. Of course the latter was not made in the usual way, although neatly finished. This beautiful and remarkable article was found not very long since.

Fig. 192 is unfinished, and those in this condition are hardly rare, but this has unusual interest from showing the mode of drilling, as well as preliminary work. It is of a hard greenish and crystalline stone, picked all over into a symmetrical form, and ground above and below. On the lower edge the work of perforation was begun

with a tubular drill, and this was interrupted when a depth of but an eighth of an inch had been reached, leaving a core in the center. The implement is thick and heavy, somewhat hatchet-shaped, the blades being about equal on either side, and it is six and three eighths wide by two inches deep. This is from the Seneca River, and not from a village site, in which it agrees with some other specimens.

Fig. 193 is one of the frequent reel shaped articles, and is nearly perfect. The material is olive brown striped slate, three and five eighths wide by two inches deep. The orifice is half an inch wide. This form expands gradually to the center, and the terminal indentations are beveled to a moderately sharp edge. Quite often the upper and lower edges are grooved throughout, but this one has a plain surface. It comes from Lysander.

Fig. 200 is one of the most beautiful of these articles, and comes from Fabius or Pompey, much resembling one in the State Museum from that vicinity. It is made of a beautiful olive green striped slate, and in form is like a slender pickaxe, having a central ridge along both sides, from end to end. Each end has a slight projection. In the center, on one side, is a partially effaced ornament. It is seven inches wide by one and one fourth deep, and the orifice is nine sixteenths of an inch in diameter. No finer example of this form is on record.

Fig. 201 is a pick-shaped article of black slate, unique in some respects. The center is enlarged by a distinct concave sweep on either side, terminating in a central flattened surface. Near this is a lateral perforation on either hand, drilled precisely as in the gorgets. No other has been reported with holes like these, and if the stone had been placed on a staff, they might have served to attach pendent ornaments. The sides are covered with transverse lines, suggesting tallies. The blades are thin, and the total length is six inches, with a depth of one and one fourth inches. It was found on a camp site on the Seneca River in 1875. The ends are abrupt, and may be either broken or unfinished.

Fig. 202 is a thick, crescent formed banner stone from Skaneateles Lake, made of green striped slate, and one inch deep by three and three

eighths wide. The ends are rounded, and the orifice is a little over half an inch in diameter, contracting slightly in the interior of the stone. There are no village sites near, and but few small camps. Fig. 203 is elliptical every way, but roundly pointed at each end. It comes from Dresden, on Seneca Lake, and there is a fault in the green striped slate of which it is made. It is three and three eighths wide, and one and one half inches deep.

Fig. 204 is a straight pick form, *a* being the profile, and *b* the basal view. The base is longitudinally grooved, and the gradual expansion makes a central ridge unnecessary. It is of light olive green slate, having a depth of three quarters of an inch, and a width of three inches. The orifice is three quarers of an inch. This is from Oneida Lake.

Fig. 205 is another unusual form of light green striped slate, with an elliptical perforation, as in Fig. 191, but not so narrow. Both ends are grooved, and the lateral edges are almost sharp. It is two and one half inches wide and one and one half deep. The thickness is three quarters of an inch. A banner stone of bluish drab slate, from the Seneca River, is a little broken, and approaches the heart shape. The perforation is half an inch in diameter, but enlarges within, an unusual feature. This article is three and three fourths inches deep and three and one half wide. Another, of similar shape and found some miles from the same river, is two and one half inches deep and two and one eighth wide. This is made of an olive and mottled slate, the perforation in which averages over half an inch wide. Another of olive slate found near the last, has straighter and nearly parallel sides. There is the usual expansion in the center, and it is nearly three inches deep by two and one quarter wide. The perforation is about half an inch. Still another approaching the heart shape is from the head of Oneida Lake, on the north side. It is of bluish olive slate, three and one quarter deep and two and three quarters inches wide, and thickened in the center. There are lines across the edges. The orifice is over half an inch, and drilling coarse. Another of similar form comes from the west end of the same lake, and is of a dark mottled slate, three inches deep and three and one fourth wide. As a rule the perforation

varies but little from half an inch. Another, of a double hatchet form, is from the east end of the same lake, and is made of a porous bluish white stone, slightly banded. There are notches on one edge, and the orifice is finely drilled, being smallest midway.

A handsome fragment is from Onondaga Lake, where it was found in 1877. The material is bluish striped slate, very smooth and thin. The broken edge, which was along the perforation or nearly so, has been smoothed, and a small hole drilled in the upper corner, placed there for its later suspension. It might be called the butterfly pattern, and the original size was six inches in width and three and one half in depth. The thin wings continue very uniform in diameter till the central ridge is reached. Another, of similar form, but thicker, and made of purple and green slate, is from the same lake, and is finely drilled. It was originally five inches wide and two and one quarter deep.

One of these, made of polished greenstone, is from the Seneca River, and is two and one eighth long by one and five eighths inches wide. The orifice, however, is so small as to make it doubtful whether it may not originally have been the stem of a large platform pipe, recut for an ornament after being broken. It seems best adapted for such a purpose. Many of the heart shaped forms might be described.

An unfinished one, much like Fig. 192, is from the Seneca River, and a little broken; it is of greenstone and angular and thick, being about six and one half inches long and one and three eighths deep. A similar one, unfinished and picked all over, is from the same river, together with the next two. It is large and thick. One of the others is nicely picked and ready for grinding, except in being unperforated. It is of greenish grey sandstone, and the oblique wings are brought nearly to an edge. It is conspicuously thickened in the center, and the wings are at an angle suggesting those of a windmill. It was found in 1883, and is six and three fourths by two and one half inches. The other is of the same general form, but deeply indented above and below, and is of light brown sandstone, picked and partly ground. It is eight and one fourth inches wide. All these unfinished banner stones have a

general resemblance and were found within a distance of a few miles. In the last drilling was commenced with a sharp point.

A finished half circular banner stone from Cazenovia, of olive slate, has one wing broader than the other, and is three and three fourths inches broad by two and one fourth deep. Another half circular one of dark grey slate, thick and unpolished, is from the Seneca River, and is four and one half inches wide by two deep. A reel-shaped one, from the same river, is grooved above and below, and one side is deeper than the other. It is of dark green striped slate, three and one fourth wide by one and three fourths inches deep. The orifice is of the usual size.

Perfect banner stones of pick and crescent forms have been found near Cayuga, Canandaigua and Seneca lakes, and in Jefferson County. They are rare along the Mohawk, though sometimes found there. A large unfinished one is from Seneca Lake, and is seven and three fourths wide. A still larger unfinished one is from Baldwinsville, and is nine and three fourths inches wide, with quite oblique wings.

One only of the double crescent form, with four horns, has been reported, and that is broken. It is of green striped slate, and was originally six by five and one fourth inches. It is from Oswego County. This rare and beautiful form is also found in Canada and Ohio. A pick or hatchet form, quite angular, comes from Sullivan County, and is of variegated soapstone, thin and polished. It is five and three eighths inches wide.

Several banner stones are from the vicinity of Owego, in Tioga County, and a fine unfinished one has lately been described, recently found in Ellington, Chautauqua County. It shows a core where drilling was commenced, but is nearly half circular in form, instead of that of those already described. A curious article, suggestive of banner stones, is from Brewerton, where several have been found, made of brown sandstone. They are nearly circular, flat and notched, and with a rough ridge left in the center, from one indentation to the other. The diameter is four inches, and they are unique. The abundance of banner stones may be inferred from the selected examples given.

GORGETS

Gorgets are found in Europe, but they are different from those in America, where there has been much speculation as to their use. There is no direct evidence that they were twine twisters, as Schoolcraft thought. The Iroquois required no artificial means in making thread, and knew nothing of these implements. Perhaps as little can be said of their use as guards against the recoil of the bow string, for which some of them certainly would have been a clumsy contrivance. Dr. Abbott's conclusion is very much better, in supposing they were ornaments variously used. They are usually symmetrical, and drilled from both sides, each perforation terminating in a smaller hole in the middle. Occasionally they are left unfinished, and often seem merely ornaments. In that case it is probable they were not so much suspended as fastened to the wearer's dress by one or more holes, like some shell gorgets; or the superfluous holes might have been for the attachment of other light ornaments to them. However this was, they certainly had no rough usage, but may well have been worn like the frontal crown and the breastplate of the Hebrew high priest.

If they were ornaments, many may have had a more practical use. A few have a chisel or a gouge-like edge. They are of very wide distribution, and perhaps are as abundant in New York as anywhere, presenting many beautiful, and sometimes rare forms. This is not generally known, because of lack of publication. Mr. Douglass has 360 in his collection, and but 20 of these are from New York, their supposed abundance or rarity depending on the collector's field or tastes. They extend across the continent.

Dr. Abbott observes that they are found near the breast in New Jersey graves, and this holds good in New York, where, however, but few occur in tombs. He found most New Jersey specimens of one form. In New York there seem no bounds to the varieties. One was taken from a grave at Deming's Point in Dutchess County, which was of dark striped slate. It had one hole and 41 tally marks. The dimensions were four and one half by two and one fourth inches. Another, with but one hole, was taken from a burial mound

at Onondaga Lake, and others are from the extreme end of Long Island.

It will be found that those of stone did not essentially differ from the shell gorgets, worn by the Iroquois in colonial days, which usually have ornamental designs and two perforations for suspension. The well known buckle of the silver brooch, still in use, shows that the Indian had a good idea of the advantage of two points of contact. With good tools the flat ornaments of shell and stone usually had two longitudinal perforations, insuring the best modes of attachment or suspension. There seems abundant testimony, historical and otherwise, that the American stone gorget was an ornament, but it is not necessary to produce all this here.

Fig. 206 has two long parallel sides, and is made from a banded yellowish olive quartzite, which is almost a sandstone. It has three holes, and another has been commenced on one side. One end is gouge-like, and the dimensions are four and five eighths by one and one half inches. It is from the Seneca River. Fig. 207, from Monroe County is very different. The base line is one and three quarters inches long, and from this the sides rise three and one fourth inches with a concave sweep. The width is then two and three eighths inches, and above this the top lines converge to a point, making the extreme length four and one eighth inches. It is of brown striped slate, and has but one hole.

Fig. 208 is one of green ribbon stone, or striped slate, much like the last but with the tip broken. It has but one hole, and the extreme length now is four and one eighth inches. This is from the Oswego River. Fig. 209 is a beautiful gorget of green striped slate from Oneida Lake. It has two holes, tapering sides, and expanded and somewhat rounded ends projecting beyond these, rather abruptly leaving the sides. The length is three and five eighths and the breadth two and one eighth inches.

Fig. 211 is a remarkable gorget of dark olive slate, found in a small mound in Jefferson County, and which could have been used only as a breastplate. It has two small holes, and the sides are generally parallel. Two of them, however, expand near the base, which becomes nearly six and one half inches wide. The general

width is four and three fourths and the height six and three eighths inches. It is not thick. Another, found with it, differs slightly from it in size and form. The height is the same, but the base becomes seven and one fourth inches wide. This is of black slate. There is a ruder and smaller one in the Toronto collection, from West Ontario, which has but one hole. It is five and three eighths inches high by five and one eighth in extreme width. These are all that have been reported of this form. The figure here given is reduced.

Fig. 212 is a more frequent form with slightly convex edges, coming to a point at each end. In this article these points have been broken off, the original length being six and one half inches. The width is one and three eighths inches, and it has two holes. The material is bluish grey slate, and it comes from the Seneca River. Fig. 213 is a gorget found a few miles from the last, and is nearly triangular. The material is a banded red slate, and there is but one hole. It is five and three fourths inches long, two and three quarters at the broad end; the narrow end three quarters of an inch wide. Both these are reduced in the illustration.

Fig. 217 is a rare form, the upper and lower edges being curved and parallel, with the upper line longest. The ends are straight, but not parallel, and there are three holes near the center. It is of grey striped slate, and was found near the Oneida River. Fig. 218 has curving sides which do not reach a point at the ends. It is of brown slate, and the edges are moderately convex. It has two holes, and the length is five and one half with a width of two inches. It was found west of Onondaga Lake. Fig. 223 is of similar but broader form, and has two holes, perforated mainly from one side. The stone is striped with cream color and purple, and is of handsome material. It was found near Beaver Lake, Lysander, and is six inches long by one and three quarters wide. Fig. 224 is a curious gorget found in the western part of Onondaga County. The base and top are slightly convex, and the lateral edges are concave. Two of the angles are rounded. It has two holes, and is sharp. The length is four and one half and the extreme width two inches. The material is striped slate.

A very pretty elliptical gorget of dark green striped slate is from the Oneida River, and has two holes. It is two and seven eighths by one and one fourth inches. A very large and thin one from the same river, has two small holes. It is of green striped slate, and nearly rectangular. The dimensions are seven and one fourth by three and three fourths inches. One of polished sandstone, but with a sharp convex edge is from Black Creek, near Oneida Lake. The form approaches the triangular, and it is seven inches long by three and three eighths wide. There is but one hole. This seems more like an implement than most, but sharp edges are not uncommon.

Those with notches, also, are not rare. One of black slate, from Lake Champlain, has notched ends and but one hole. It is seven inches long by one and seven eighths wide. Others might be described from Chautauqua County, with this feature, as well as from other places. In fact they were so striking a part of personal decoration in early days, that they may be said to occur everywhere.

GROOVED AXES

Grooved axes are extremely rare in most parts of Vermont, New York and Canada, though not altogether unknown. Out of 419 in Mr. Douglass' collection but two were from New York, and Dr. Rau figured none. Mr. Gerard Fowke said, 'In the eastern and interior States the grooved axes are far more abundant than the celts of the same size, because, as a rule, only the larger implements of this class are grooved. All the ordinary varieties of axes and hatchets are found about Lake Champlain, by far the most abundant being celts or grooveless axes.' Between there and Lake Erie a grooved axe is a rare find indeed. In the later days they were not in use among the Iroquois as far as appears, and it may be questioned whether some occasionally found in New York, may not in some instances have been lost by collectors.

In his history of Onondaga, Mr. J. V. H. Clark represented that hundreds of these, particularly described, had been found on an Elbridge site, but farther inquiry proved this an unaccountable mistake. They sometimes occur, but are evidently foreign to the soil.

Fig. 215 is a narrow form, of light greenish stone with a groove all around. This is reduced in the figure and is from Jefferson County. Some occur of the more typical forms, specially in the southwestern part of the State. They are said to be more numerous east of the Mississippi than west, but this may be due to the number of collectors. The southern Indians have used them in historic times. The single grooves were for attaching the handles, and sometimes there are double grooves. They have been used by the Pueblo Indians.

While so rare in New York, Dr. Abbott reported many from New Jersey, and from every part. One axe weighed nearly 14 pounds, and several large caches of these implements have been found there. One contained 120 axes. Among three from Tioga County, N. Y., was one of eight pounds. There were none in the Wagman collection at Saratoga.

Celts and gouges are sometimes roughened or grooved for securing the handle, and a few broad axes rather suggest than have the groove. Fig. 219 is a flat axe of brown sandstone, not grooved across the surface, but with a deep and broad notch in each lateral edge. It is a rare form, altogether unlike the typical implement.

POLISHED PERFORATORS

Fig. 221 is a neat polished perforator of brown sandstone, from Madison County. It is two and three eighths inches long, and much like some bone perforators in general appearance. Those like this are rare, for the early comers used flint, and the Iroquois very much preferred horn and bone, yet these seem to have belonged to them.

Fig. 222 is from the same place, and is notched and more angular. The broadest part is near the point. This is two and three fourths inches long. Another of black basalt, with an oblique central notch, comes from the Nichols Pond site, the Oneida town of 1615. It is three and one eighth long by five eighths of an inch thick. This is decisive of its Iroquois use, but such a splinter of stone might be ground as easily as bone, the general form being the same.

GROOVED BOULDERS

In the Onondaga and Seneca territory specially, are found large boulders with straight grooves, from one to seven in number, and

very uniform in depth and width. Occasionally small stones are grooved in the same way. Fig. 241 is a reduction of one of these from the Minden earthwork, south of Fort Plain. It is a block of sandstone, 15 by 18 inches across, and has two grooves of the usual width and character.

Another of these, but much smaller, comes from Schoharie, and is five and three fourths by three and three fourths inches. This has three parallel and one cross groove, but they are reported much narrower than usual, being but little over a quarter of an inch wide. The block is of grey sandstone. Another small one comes from Frenchman's Island, in Oneida Lake. In this the groove is three quarters of an inch wide, with another partly within it. A few other small ones have been found, but usually large boulders were used. Of these larger ones Dr. Rau mentioned some in Massachusetts and New York.

One of clay slate and of irregular form comes from Dutchess County, and is 17 by 13 inches, and seven inches thick. It has one perfect groove, now 10 inches long, but originally more. This is half an inch wide and three eighths deep. Another groove is unfinished. One from Deming's Point is broken through the center of the second groove. This is now 10 inches long, but originally more. The width is five eighths and depth three eighths of an inch. Striæ appear in both.

The most remarkable of the large grooved boulders, is that described by Clark in his history of Onondaga, and it was the first to attract much attention. The Gothic letters XIIIII fairly represent the arrangement of the grooves. The boulder is of corniferous limestone, 23½ by 22 inches across. The grooves are wider than usual, being three quarters of an inch, and the striæ are obscure. The longest groove is about 15 inches. It was in the ravine by the old Indian Fort in Pompey, reputedly of recent occupation. Another from that vicinity is also of limestone, 26 by 22 inches across. There are seven grooves irregularly dispersed, five eighths wide and three eighths of an inch deep. The grooves are about seven to 12 inches in length. A small block of blue limestone, much weathered, has two grooves. Another in the same condition, has

five grooves, and the block is 16 by 18 inches. One of these grooves intersects the rest. They are five eighths wide, and three eighths of an inch deep. One of red sandstone, 15 by 18 inches, has one groove, 14 inches long, and of the usual width and depth. Some of these Pompey stones came from historic sites, and were undoubtedly used within the last three centuries.

A fine one of sandstone, from Yates County, has three grooves about 20 inches long and of the usual width and depth. Another has five grooves, and still others have been found there. Two were found in Hector, Tompkins County. One is of slate, 10 by 10, and about three and one half inches thick. It has five grooves across the face, which are nearly parallel. Four of these are but little over half an inch apart, and are half an inch wide and a quarter deep. The fifth is a little wider. The other stone is also of slate, eight and one half by 12 inches, and three and one fourth thick. It has two grooves, and all these are striated like the rest.

Two more in Pompey are on either side of a stream, and partly imbedded in the banks. The exposed part of one is 24 by 30 inches, and the ends of the five grooves are buried in the earth. They are nine, 16, 14, 11, and eight and one half inches long. The boulder is common limestone. The other is in the west bank of the stream, and is of corniferous limestone, partly exposed. Both boulders extend into the brook. The exposed part of this is 24 by 30 inches, and has two grooves, which are nine and 10 inches long. The grooves and striæ are carried through the flint nodules as in the others, a feature best seen when the stone is wet.

The use of these stones is of interest, and nothing has been suggested but that of straightening and smoothing arrow shafts, by rubbing them in these grooves. There are objections to this, but they may not be insuperable. In the case last mentioned, the pointing of the grooves against a steep bank would embarrass arrow making, the most convenient position being parallel with the stream. If the shaft were long the difficulties would be increased. That water and sand were used may be inferred from the parallel striæ, and the usual position near a stream. That the grooves were made with a purpose directly connected with their size, may be inferred

from the uniformity of that size, and the absence of narrower and shallower grooves. As to the period, they may have been in use in Onondaga County and vicinity for a hundred years after the forming of the Iroquois League, but probably less.

The Indians of the present day have simple methods of arrow making, and whether their fathers made these grooves with so much labor, for this purpose, may be a question still. The strong point is that there is no other apparent use for them.

Grooves of another kind are not rare, and among these are the sharper cuts made by sharpening tools on boulders. A large stone was often very convenient for this purpose, and some may still be seen on old village sites. As the Indians learned to melt and cast metals, they sometimes made use of a small stone for a matrix, and such stones are occasionally found. So are whetstones, easily recognizable by their marks of use. They are commonly slender and small.

After the foregoing was written, Mr. A. G. Richmond described a large grooved boulder, weighing 1970 pounds. Of this he says, 'There are three grooves at one end, pretty well off on the slope. Three more toward the center, and a seventh one started in the center.' He thinks they were certainly used in working arrow shafts, and while there are certain difficulties in the position of those found in place, he makes suggestions worthy of consideration. These are quoted here, 'My theory is, and it would answer on every stone I have seen, that they sat astride, and worked the arrow in front of them, as my observation is that they all have grooves across, rather than lengthwise of the stone. Another thing makes me think they were made for this purpose, and that is that when the groove reaches a width sufficient for the maximum size of arrow shafts, they proceed to make a second groove. If it was for some purpose that did not require a uniform or absolute size, one groove would answer every purpose.'

The crosswise grooving, however, while general is not invariable. The uniformity of the grooves, of which he speaks, is one of the remarkable features of these curious stones.

MISCELLANEOUS

Fig. 220 is an elliptical brown sandstone pebble, two and one sixteenth inches long by seven eighths of an inch wide, and having a central groove and notched ends. It may have been a sinker. Fig. 236 is a perforated ball from Elbridge, found near an earthwork. It is a soft brown sandstone, one and seven eighths wide by one and three eighths inches deep. The top and the bottom are unequally flattened, and the diameter of the opening is less than an inch. A curved yellow stone, much like a horn in outline, is perforated at the broad base. It comes from the Oswego River.

Many years ago a fine carving made from the black slate of the northwest coast, and in that style, was found in Tioga County, but whether it was brought by an Indian or lost by a white man, may be a question. It is a characteristic piece, and of its ultimate origin there can be no doubt. A Sandwich Island adze was found in Marcellus some years since, but the cause for this seems clearer. It was brought there by a recent traveler, was lost and found again. Similar instances might be cited of unexpected articles found even in Indian hearths and graves.

Mr. Fowke considered stone cones rare in the South and West, and they are still rarer in New York. A true stone cone, however, comes from Jefferson County, and is two inches high. They have been reported nowhere else, but small pyramids occur. A pebble, flattened like a muller, has a groove lengthwise from the flat surface at each end. It is four inches long, and comes from Cayuga County, where other odd forms are found. An oval pebble, with perforations representing eyes, has its edges chipped. This is from Brewerton, but similar things occur elsewhere, being usually recent forms. Many puzzling pieces are probably unfinished, and of the intention of others we know very little. Some doubtful forms have been passed over, there being no present occasion to discuss their authenticity, while others of undoubted value have been regretfully left unnoticed.

Plates, blocks and ornaments of mica have been found in Cayuga, Cattaraugus, Chautauqua, Chenango, Monroe, Oswego, Suffolk, and perhaps other counties. They are quite rare.

While the Iroquois made many records by pictures, these were usually on wood or bark, but sometimes were painted on stone. Such examples were known in St. Lawrence and Montgomery counties. No engraved pictures in rocks have been reported here, but a few occur in large stones, notably on the Hudson. There is an account of footmarks in stone in Suffolk and Westchester counties, and in the latter mortars are common, excavated in the rocks.

Stone heaps occur sparingly all over New York, and there are frequent allusions to the aboriginal custom of casting stones on such heaps, in early records. The stone heap near Schoharie creek was the most noted of such monuments, and was constantly added to as late as 1753, if not later. Such heaps sometimes covered graves, but not invariably. The Schoharie tumulus was reported as four rods long, between one and two wide, and from ten to fifteen feet high, being of the largest size. An early account of it will be found in the *New York Documentary History*. Small heaps of stone are sometimes found within the lines of forts, gathered as defensive missiles, but they are not conspicuous.

This bulletin completes a general view of the stone implements and ornaments of the aborigines of New York, to which the paper on articles of chipped stone formed the introduction. Abundant materials are in hand for others on the interesting earthenware of our early inhabitants, as well as their articles of bone, horn, shell, wood and metal, of scarcely less interest and beauty, should it be determined to complete such a series. Any information on either rare or common articles of this kind will be gratefully received. Figures are desirable, with full descriptions available for record, but specially notes of locality. This most important point in comparative study should never be neglected. Of course contributions to the State Museum are very desirable, and many collectors may be disposed to do a public service in this way, but clear and full notes, to be compiled and preserved, will be an acquisition of no

small value. Maps of localities, with descriptions of sites and finds, will be no less prized, specially from places where little has yet been done. These preliminary bulletins will reach many, it is hoped, who will take an active interest in the matter. There are many good private collections of aboriginal articles, and a simple systematic description of the New York relics in these would be a great aid in scientific research. It is a work in which many might and should share, and the prospective results are great indeed.

EXPLANATION OF PLATES

Many figures are greatly reduced for lack of space, and for convenience in arrangement some small ornaments are not placed in consecutive order. For full descriptions given in bulletin, see index under *Plates*.

FIG.	NAME	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	DEPTH OR HIGHT
1	Celt	Greenstone	5⅜	2	
2	"	Brown sandstone........	4⅝	2⅛	
3	Plummet	Slate	2	....	
4	Celt	Green striped slate........	3¾	3⅛	
5	Ornament	Red pipestone	1½	+¾ wide base —¼ nar'w end	
6	Chisel..........	Brown sandstone.......	5⅞	1⅛	
7	Celt	Grey "	3⅛	$\frac{9}{16}$	
8	"	Brown "	4	¾	
9	"	Green striped slate.....	4⅛	....	¾ deep
10	"	Brownish drab sandstone	8	2⅛	
11	Chisel	Black basalt	2⅛	¼	
12	Celt	Greenstone	2¼	⅜	
13	"	Black basalt	3	1	
14	"	" "	3⅞	1⅞	
15	"	Light olive green slate..	2¾	1½	
16	"	Dark green striped " ..	4½	2½	
17	"	Quartzite	2¼	1½	
18	"	Brown sandstone.......	1¾	½	
18 [a]	"	Black basalt............	1¾	¾	
19	"	Grey sandstone	5½	2¼	
20	"	Green striped slate.....	2¼	1½	
21	"	Light olive green "	5⅛	2⅜	
22	"	Brown sandstone.......	4⅛	1	
23	"	Striped slate...........	6⅞	⅞	⅝ deep
24	"	Brown sandstone.......	3⅜	1	
25	"	" "	2⅜	⅝	
26	"	Dark slate..............	11½	1¼	
27	"	Dark steel grey sandstone	9	$\frac{15}{16}$	
28	Pick or hoe....	Polished sandstone.....	9¼	....	1¾ thick
29	Celt	Green slate.............	3½	1⅛	
30	Adze..........	Brown sandstone.......	9⅞	1⅜	
31	Celt	Grey granite...........	1⅝	1⅛	
32	"	Dark green marble.....	2⅛	2	
33	"	Black basalt...........	1½	$\frac{13}{16}$	
34	"	" "	5⅜	2	
35	"	Basalt	1¾	1⅝	
36	Gouge	Bluish striped slate.....	7⅜	2⅛	
37	"	Brown hæmatite........	3¾	2¼	
38	"	" sandstone........	3⅜	1½	

a For special names of ornaments, see description in bulletin.

EXPLANATION OF PLATES, *continued*

FIG.	NAME	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	DEPTH OR HIGHT
39	Gouge	Black basalt	2⅞	1¼	
40	“	Grey sandstone	4⅝	1¾	
41	Ornament	Red pipestone	1+	....	
42	Gouge	Greenstone	6¼	2½	
43	“	Mottled “	4¾	2	
44	Ornament	Sandstone	1	1	⅜
45	Gouge	Black basalt	8¼	2¼	
46	Ornaments (3)	Stone beads	½	½	
47	Stone ball	Black slate	1	$\frac{15}{16}$	
48	Beads	Slate	$\frac{15}{16}$	$\frac{13}{16}$	
49	Stone ball	Dark grey quartzite	......	2⅛ diam	
50	Ornament	Sandstone	⅞	....	
51	Stone ball	Pink quartzite	......	2½ diam	
52	Ornaments	Clay concretions	various	....	
53	Stone ball	Black slate	1	⅞ diam	
54	Gouge	Dark olive green slate	5	2	
55	“	Ironstone	4⅛	1⅞	
56	Ornament	Pipestone	3½	1¼	
57	“	Red slate	1	....	
58	“	“	......	1¼ diam	
59	“	Pipestone	.....	1+ “	
60	“	“	1⅝	1⅛	
61	Gouge	Mottled stone	4⅛	2⅜	
62	Pebble	Brown sandstone	......	3⅜ diam	1½ thick
63	Pestle	Grey “	7	....	
64	Double muller	Grey sandstone	3½	3½	2⅞ deep
65	Pestle	Sandstone	3⅜	1	
66	Adze	Black slate	4½	3¾	
67	Pestle	Brown sandstone	8¾	2¼	
68	“ (carved)	“ “	15	2½	
69	“ “	Sandstone	6¾	1¾	
70	“	[a]	9½	2¼	
71	“	Brown sandstone	8⅜	1¾	1⅛ thick
72	Celt and gouge	Grey “	2¾	1¾	
73	Pestle	Brown sandstone	5¼	2¼	
74	“	“	2½	1¾	
75	“	Grey sandstone	4⅛	2¼	
76	Muller	Sandstone (pebble)	¾	¾	
77	Sect'n of a vessel	Potstone	......	20 across handles	10 high
78	P'ce of potstone [b]	“	2	1½	1 deep
79	Notched potstone rim	“	......	3¼	2¾
80	Sinker	“	2⅜	1⅛	
81	Handle	“	......	1½	1½ proj.
82	Ornament	Pipestone	......	1 diam	

[a] Not given. [b] Use unknown.

EXPLANATION OF PLATES, *continued*

FIG.	NAME	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	DEPTH OR HIGHT
83	Handle	Potstone	......	3	2¼ proj.
84	Ornament	Light drab slate.........	1¾	¼	
85	Pestle.........	Brown sandstone.......	1⅜	¾	11/16
86	Sinew stone....	"	3⅞	1⅝	
87	Ornament	Pipestone	......	11/16	
88	Beads.........	Slate	⅞	....	
89	Pestle.........	Brown sandstone	4⅝	1⅜	
90	Plummet	Dark "	4½	....	1⅛ thick
91	"	Grey "	4¼	....	1½ "
92	"	Red "	3⅝	1½	
93	"	Greenstone	3½	1½	
94	"	Red granite	2	1¾	
95	"	Hornblendic gneiss.....	2½	1⅛	
96	"	Greenstone	3	1⅜	
97	Pipe	Black soapstone........	......	....	4½ high
98	"	Yellow sandstone.......	......	....	1⅞ "
99	"	Dark soapstone	......	......	1⅞ " 1¼ deep
100	"	Black marble	4¾	....	
101	"	White "	......	....	2⅜ high
102	" bowl......	Dark soapstone	......	....	1⅞ "
103	Bird pipe......	" green slate	......	....	7½ "
104	Pipe..........	Yellowish grey stone	2½	2¼	⅞ "
105	"	Soapstone	......	1¾ (?)	1½ "
106	"	Black marble...........	3⅜ fr. tip to "	....	
107	"	Grey quartzite	......	....	2¼ "
108	"	Dark soapstone	......	....	1½—"
109	"	Dark slate.............	5⅛	....	2¼ "
110	"	Grey stone.............	3½	....	2 "
111	"	Brown sandstone.......	......	......	2 " 1¾ thick
112	"	Sienna marble..........	......	....	2¼ high
113	"	Sandstone	......	....	2½ deep
114	"	Dark stone.............	......	....	3½ high
115	"	Crystalline "	3¾	....	
116	"	Sandstone	......	......	2¾ high 1¼ deep
117	Bird pipe......	Green slate	3¾	....	
118	Pipe	Steatite	3¾	1 diam	
119	"	Grey limestone.........	......	....	2 high
120	"	Dark soapstone.........	2¾	....	
121	Muller	Greenstone	......	4	2 deep
122	Tube	Dark green striped slate..	3½	1¼	
123	"	Grey striped slate.......	5⅝	1 diam	
124	"	Light olive green slate..	3¼+	....	
125	"	Striped green slate......	7	....	

EXPLANATION OF PLATES, *continued*

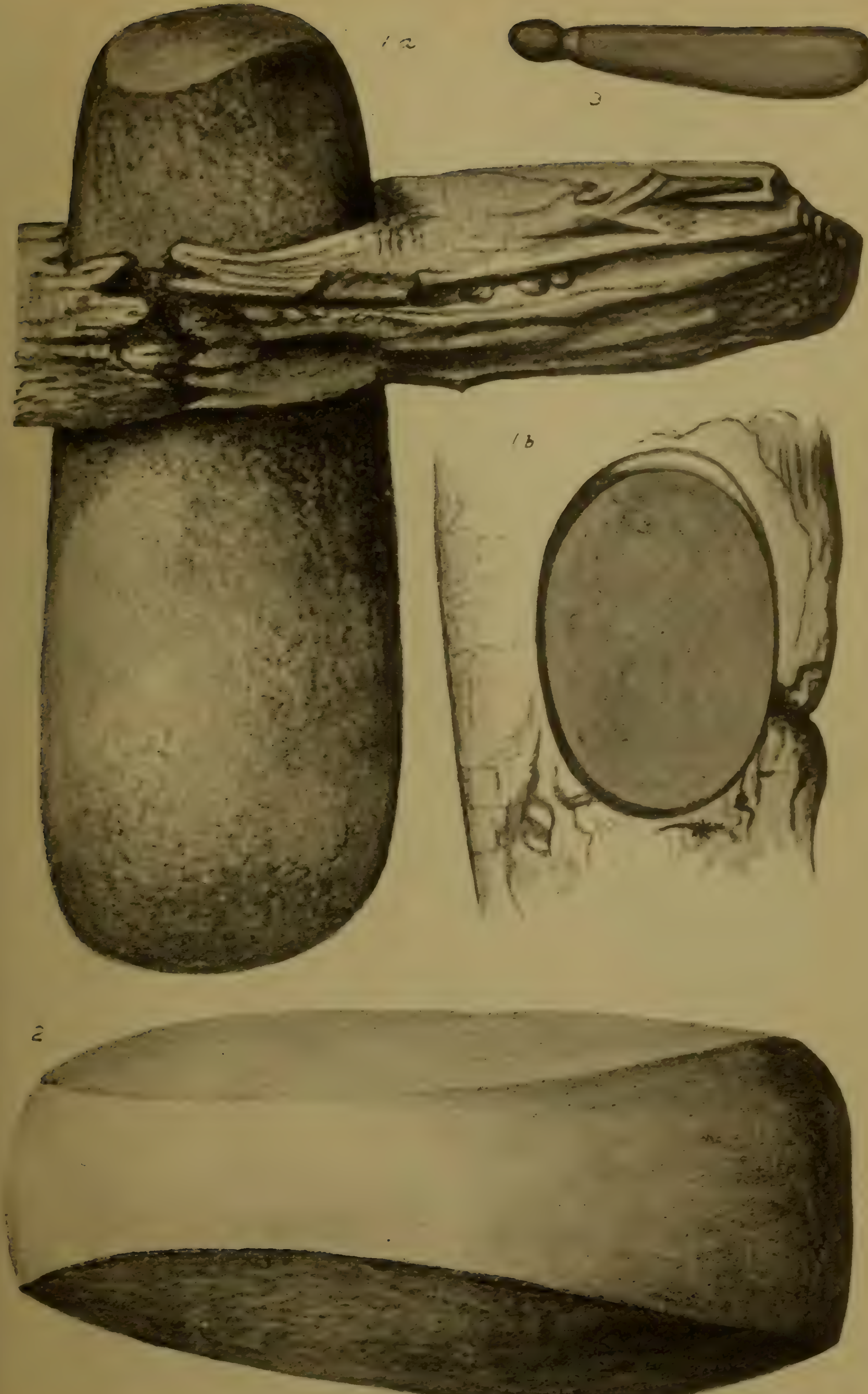
FIG.	NAME	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	DEPTH OR HIGHT
126	Ornament	Greenish slate..........	......	$\frac{11}{16}$ long diam	
127	"	"	$\frac{11}{16}$+	....	
128	Tube	Sandstone (?)	9½	1⅛ diam	
129	"	Sandstone	4½	1¼ diam	
130	"	Soapstone	8½	....	
131	Bayonet slate ..	Bluish striped slate......	8⅞	⅞	
132	" " ..	Striped slate............	4⅞	....	
133	Plummet	Brown sandstone	$2\frac{5}{16}$	1⅜	
134	"	Quartz	2½	1¼	
135	Amulet	Green striped slate......	......	9⅞ fr. tip to tip	
136	"	" "	3½	....	1½ high
137	"	" "	6⅛	3 at tail	
138	"	Pipestone	$2\frac{3}{16}$	....	
139	"	Green striped slate......	3¼	....	
140	"	Trap rock	6⅞	....	1½ high
141	"	Mottled stone...........	3⅜	....	1¾ "
142	"	Green striped slate......	4½	....	1 high at tail
143	"	" "	5	....	1¾ high
144	"	" "	3⅜	....	1⅜ "
145	"	Grey "	5⅝	....	
146	"	Mottled dark stone.......	4½	1¾	
147	"	Dark green striped slate..	5⅞	¾	¾ high
148	Ornament	Pipestone	⅝	....	
149	"	"	$1\frac{9}{16}$	$\frac{13}{16}$	
150	"	"	$\frac{3}{16}$	....	
151	Pipe..........	Dark green soapstone ..	3	....	1⅛ thick
152	"	Green sandstone.........	3¾	....	
153	"	Stone..................	3⅝	....	
154	Boat stone.....	Striped slate............	4⅛	1+	⅞ high
155	"	Green striped slate......	3¾	1⅛	¾ "
156	"	Brown slate............	3⅛	....	1⅛ "
157	"	Green striped slate......	5½	....	1⅜ "
158	"	" "	4¼	1½	1¼ "
159	Cup	D'k blue gr'n striped slate	......	2¾	
160	"	Soapstone	......	2⅝ long diam	
161	D'ble edg'd knife	Grey slate.............	2⅜	1¼	
162	Ornament......	Brown sandstone........	......	1 diam	
163	Cup	" "	......	1¼	
164	D'ble edg'd knife	Grey slate.............	2¼	1¼	
165	Sinker (?).....	Light greenish slate.....	4¾	¾	
166	D'ble edg'd knife	Dark slate	5⅝	1¼	
167	"	Grey "	3¾	1⅜	
168	"	Dark "	1⅝	....	
169	"	" "	2½	1	
170	"	Red "	1⅝	1⅛	

EXPLANATION OF PLATES, *continued*

FIG.	NAME	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	DEPTH OR HIGHT
171	D'ble edg'd knife	Bluish slate............	2⅜	1¼	
172	"	Dark "	3	1⅜	
173	"	Grey "	1¼	½	
174	Omitted........	....	......	....	
175	D'ble edg'd knife	Dark "	3¾	1⅜	
176	"	Grey "	2⅞	1⅛	
177	Woman's knife..	Slaty sandstone.........	2⅞	....	2¼ deep
178	" ..	Hard black slate........	3	....	1⅛ "
179	" ..	Brown sandstone........	......	5½	2 "
180	" ..	Grey sandstone.........	......	6⅛	2¼ "
181	Ornament......	Pipestone	2⅛	1+	
182	"	"	$1\frac{5}{16}$	⅜	
183	"	"	1	¾	
184	Hammer stone..	Light green slate.......	......	4⅜	2¾ deep
185	" ..	Green striped slate......	4	1⅛	¾ "
186	" ..	" "	......	5⅜	4½ "
187	" ..	Striped slate	......	5½	2⅝ "
188	" ..	"	......	4⅝	1⅞ "
189	" ..	Olive green slate	......	2¾	4⅛ "
190	Ornament......	Pipestone	......	....	
191	Hammer stone..	Green striped slate......	......	2⅝ diam	
192	" ..	Greenish crystalline stone	......	6⅜	2 deep
193	" ..	Olive brown striped slate	......	3⅝	2 "
194	Ornament......	Pipestone	1	½	
195	"	"	1⅞	1	
196	"	Marble	......	⅞	1⅛
197	"	"	......	1	1
198	"	Pipestone	¾	....	
199	"	"	......	1⅛	$\frac{3}{16}$
200	Hammer stone..	Olive green striped slate.	......	7	1¼ deep
201	" ..	Black slate	6	....	1¼ "
202	Banner stone...	Green striped slate......	......	3⅜	1 deep (?)
203	Hammer stone.	" "	......	3⅜	1½ deep
204	" ..	Light olive green slate..	......	3	¾ "
205	" ..	Striped slate...........	......	2½	1½ " ¾ thick
206	Gorget........	Yellowish olive quartzite	4⅝	1½	
207	"	Brown striped slate.....	4⅛	2⅜ 1¾ at base	
208	"	Green ribbon stone.....	4⅛	....	
209	"	" striped slate.....	3⅝	2⅛	
210	Ornament	Pipestone	2⅜	⅜	
211	Gorget........	Dark olive slate	....	6½ at base 4¾	6⅜ high
212	"	Bluish grey "	6½	1⅜	

EXPLANATION OF PLATES, *continued*

FIG.	NAME	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	DEPTH OR HIGHT
213	Gorget........	Red slate	5¾	2¾ oad end ¾ nar'w end	
214	Boat stone....	Brown slate	5⅛	1¼	⅞ high
215	Grooved axe...	Light greenish slate.....	5¾	2½	
216	Plummet	Green basalt...........	$1\frac{13}{16}$	....	1 thick
217	Gorget........	Grey striped slate.......	......	4⅛	2⅛
218	"	Brown slate	5⅛	2	
219	Flat axe.......	" sandstone.......	4¼	2⅞	
220	Pebble........	" "	$2\frac{1}{16}$	⅞	
221	Polished perf...	" "	2⅜	....	
222	" ...	Sandstone	2¾	....	
223	Gorget........	Striped (cr'm & pur.) stone	6	1¾	
224	"	Striped slate	4½	2	
225	Ornament......	Limestone	......	1½	
226	Mask..........	Pipestone	......	¾	1
227	"	"	......	$\frac{9}{16}$	⅝
228	"	"	......	¾	¾
229	Ornament......	"	......	¾	
230	"	"	......	$\frac{11}{16}$	½
231	"	"	......	$1\frac{5}{16}$	$\frac{9}{16}$
232	Mask..........	"	......	¼	⅝
233	"	"	......	$\frac{7}{16}$	½
234	Ornament......	"	3	1⅝	
235	"	"	2⅝	1⅝	
236	Ball (perforated)	Brown sandstone	......	1⅞	1⅜ deep
237	Ornament.......	Pipestone	......	1	$1\frac{3}{16}$
238	Mask..........	Grey marble	......	1⅜	1¾
239	Cob. st'ne (carv.)	Sandstone	......	2½	3
240	Ornament.......	Pipestone	......	$\frac{11}{16}$	⅜
241	Grooved bould.	Sandstone	18 (?)	15	
242	Ornament	Slate	......	1⅛	1⅜
243	"	Pipestone	1⅛	$\frac{7}{16}$	
244	"	"	1½	$\frac{3}{16}$	
245	Ornament (serp)	Greenish slate..	3⅞	¾	



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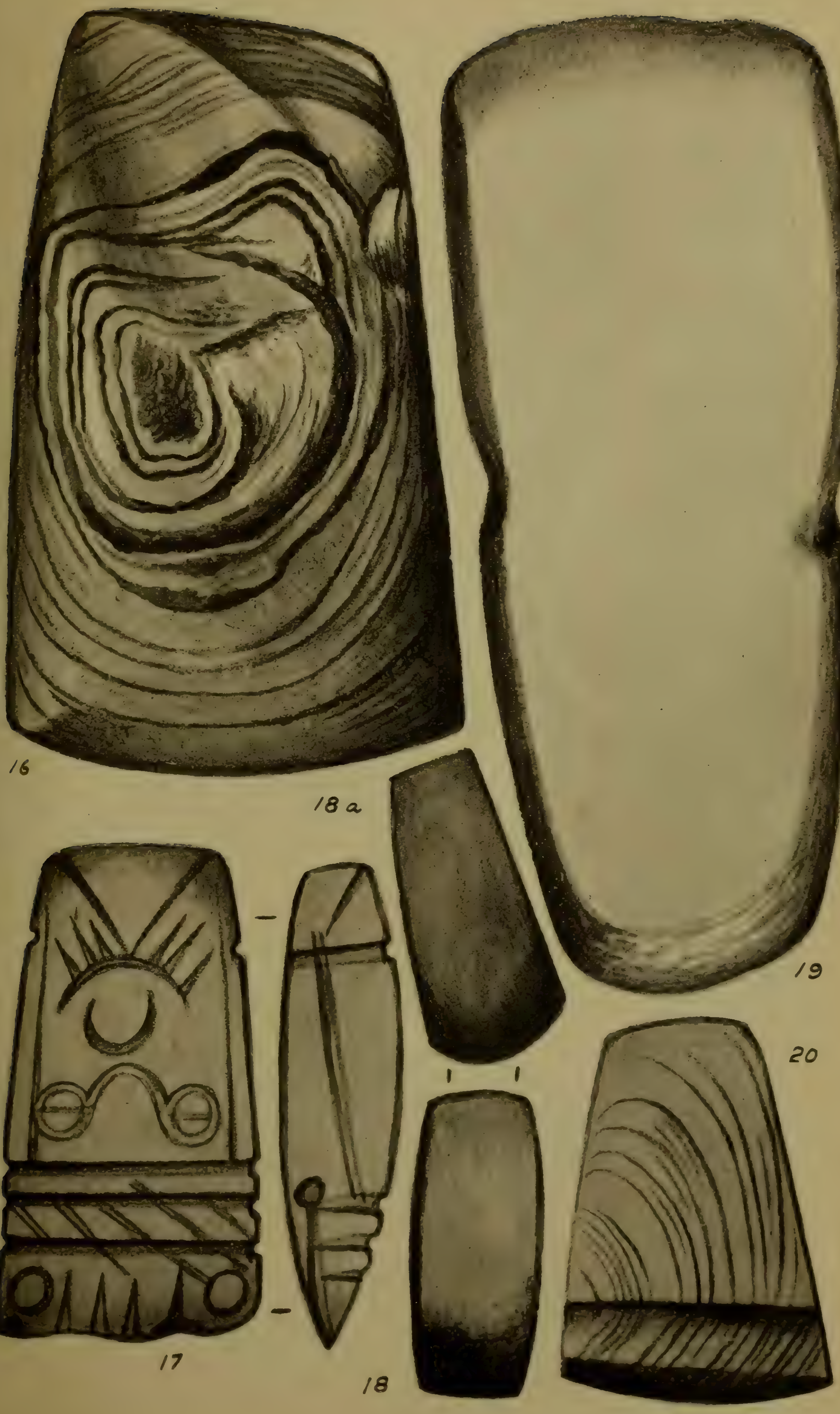
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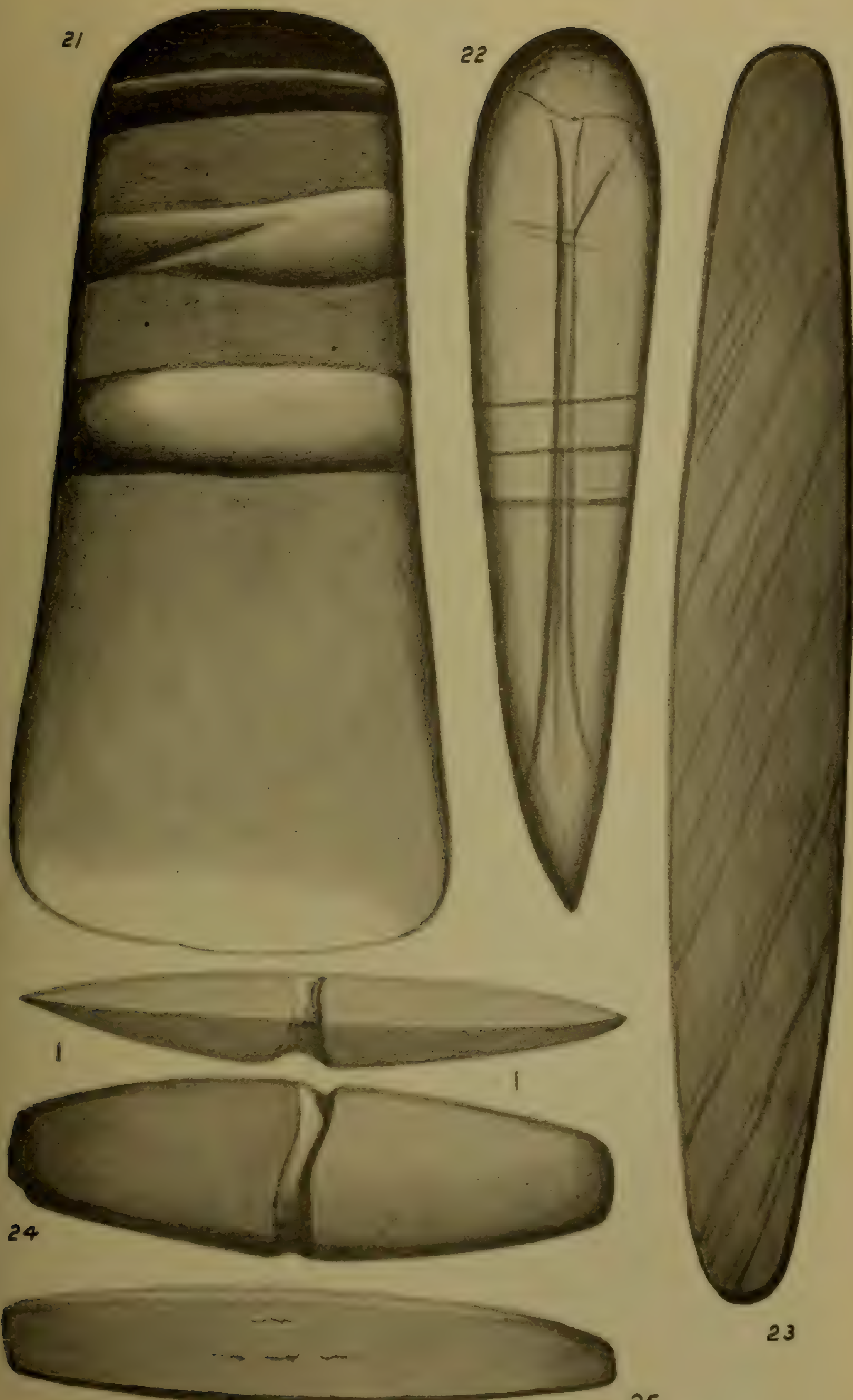
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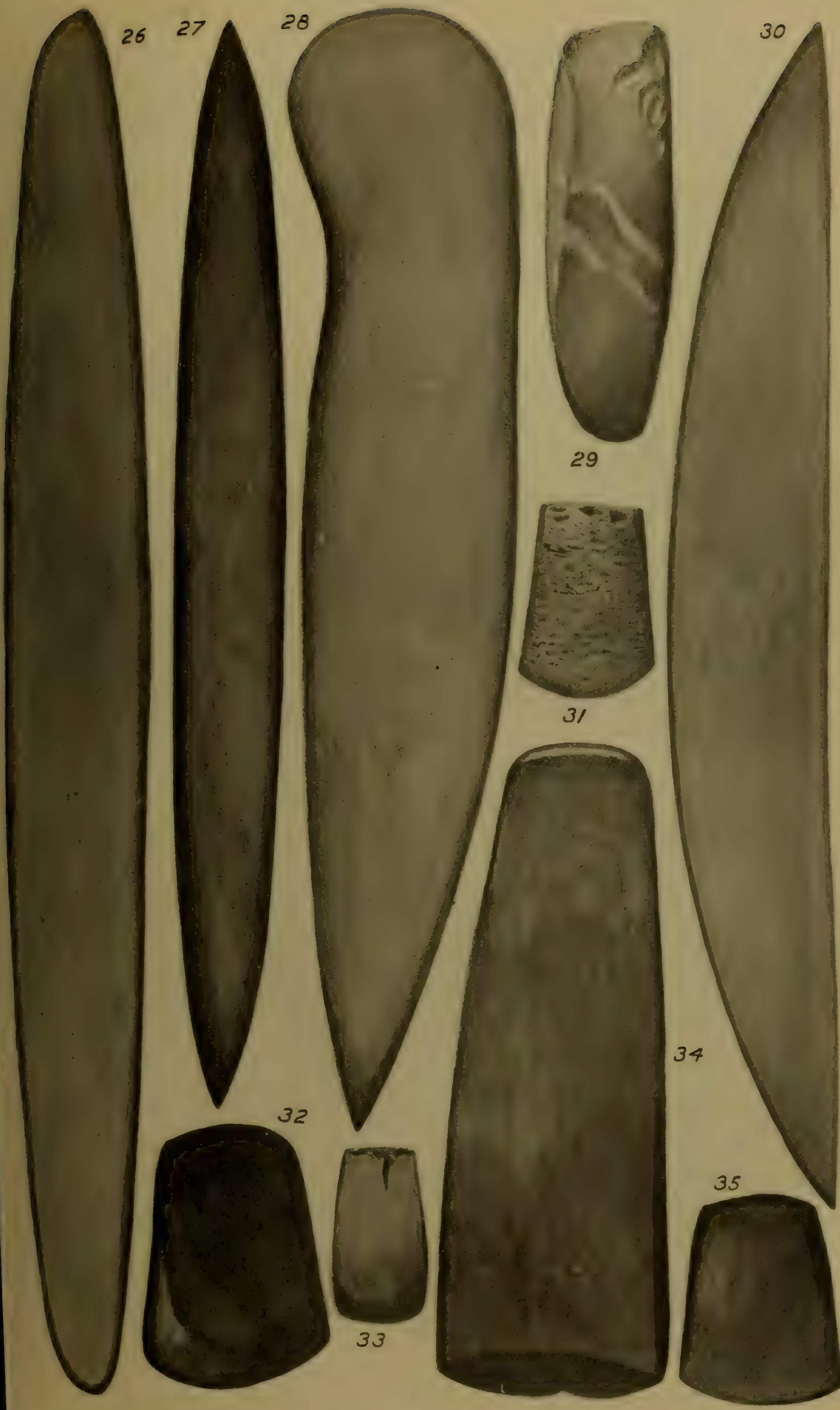
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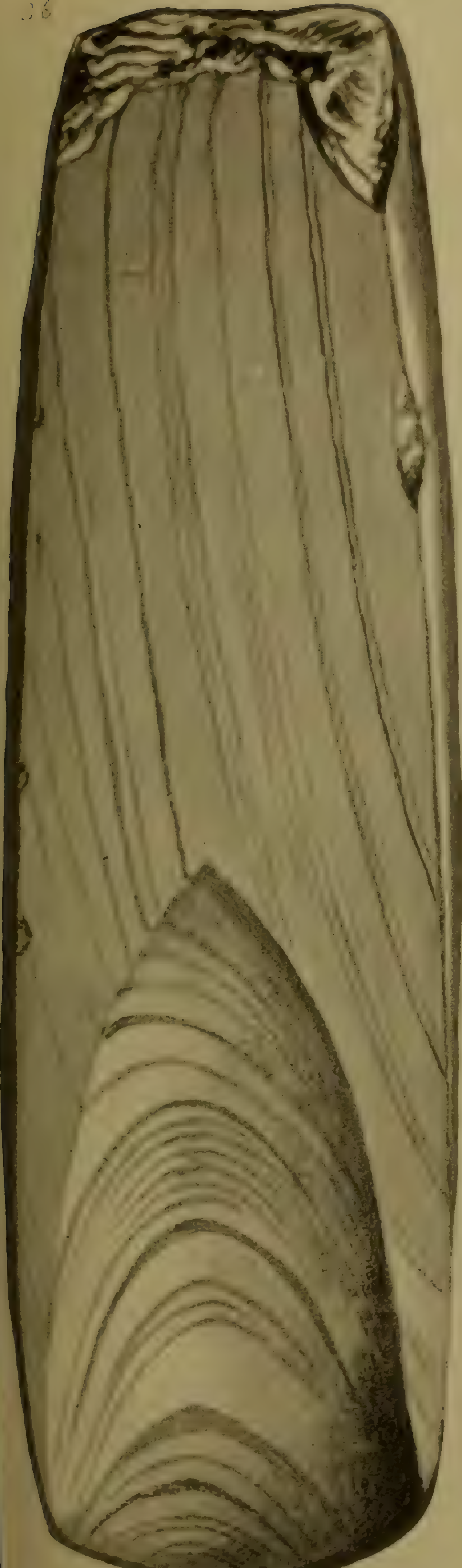

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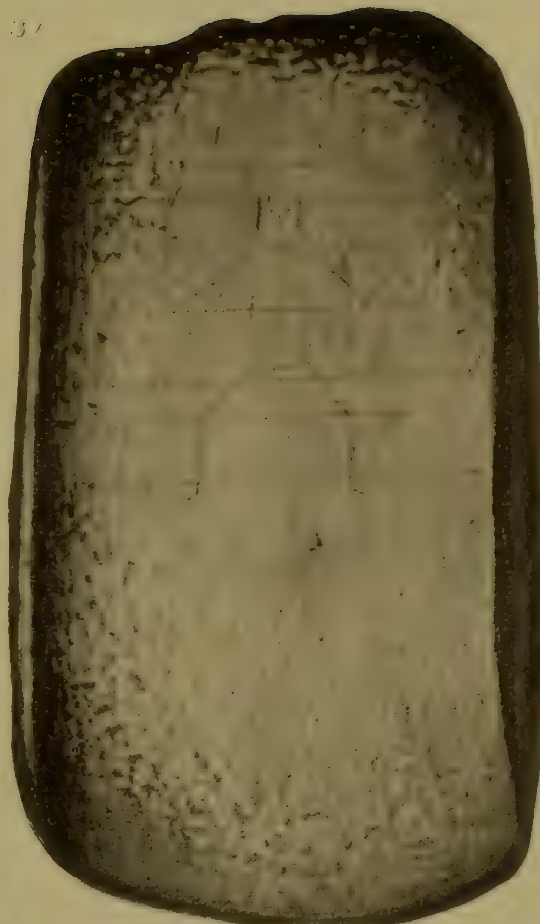

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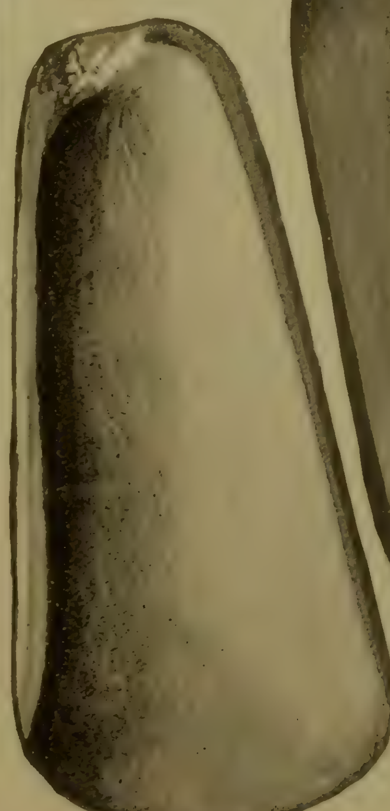

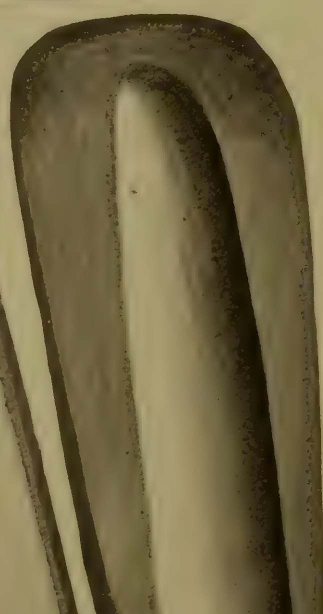

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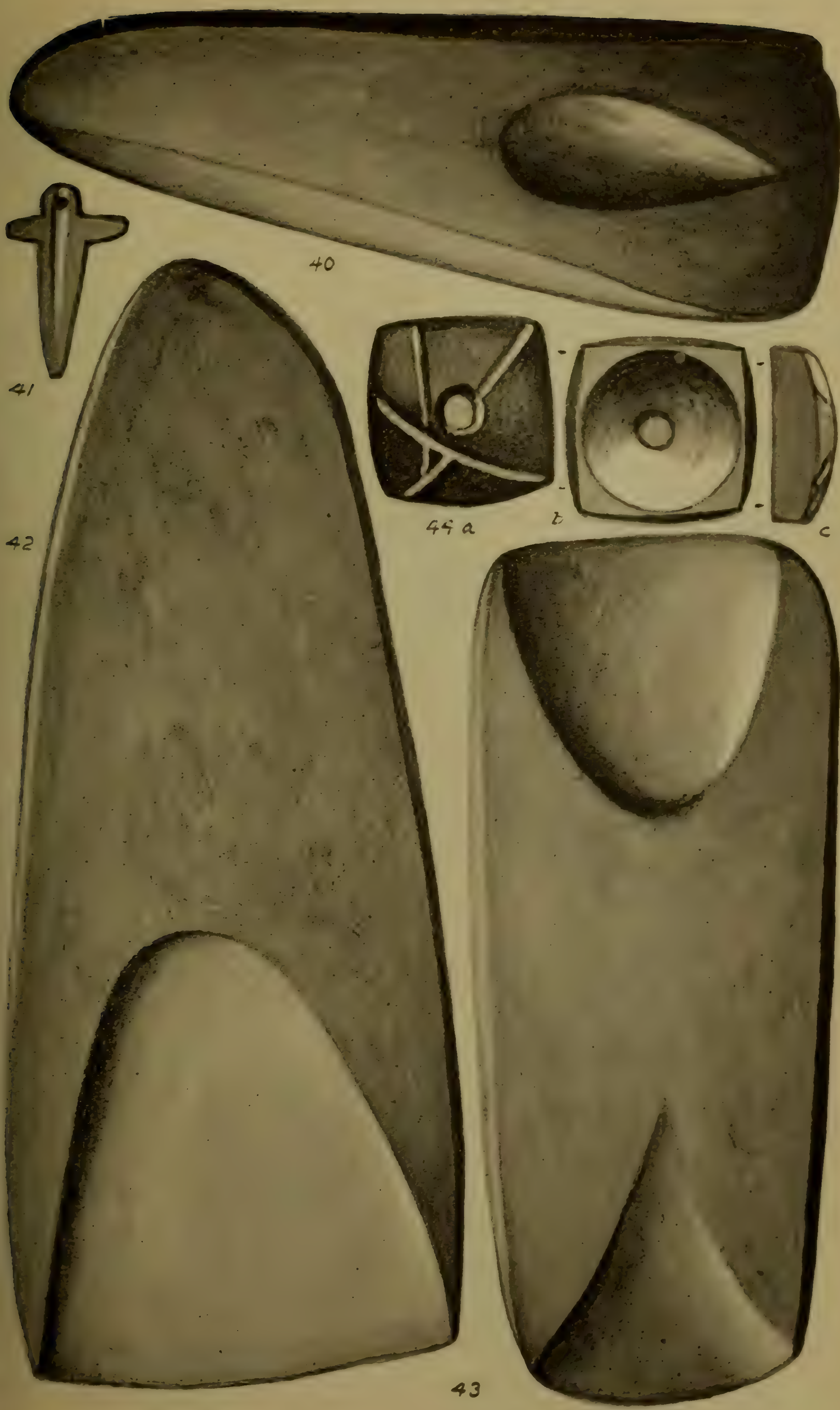
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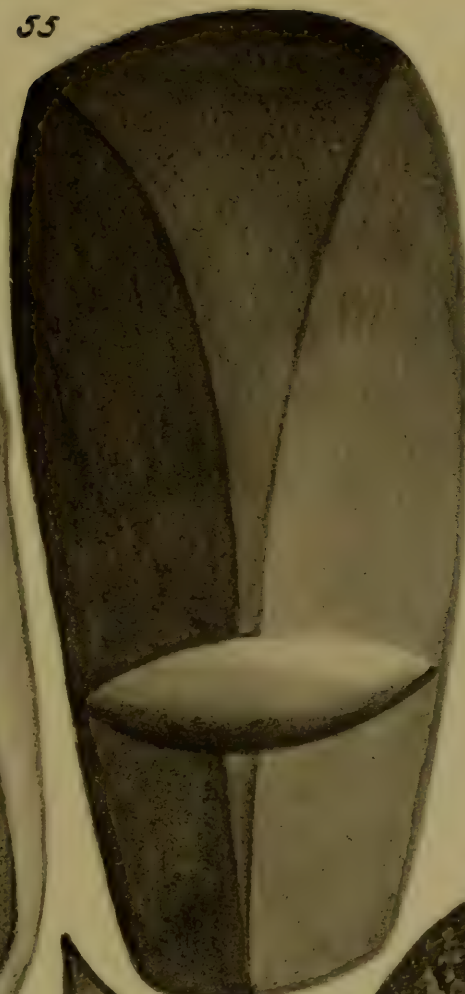

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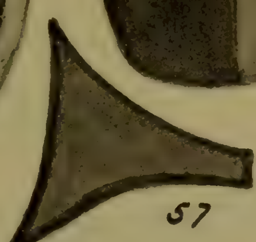

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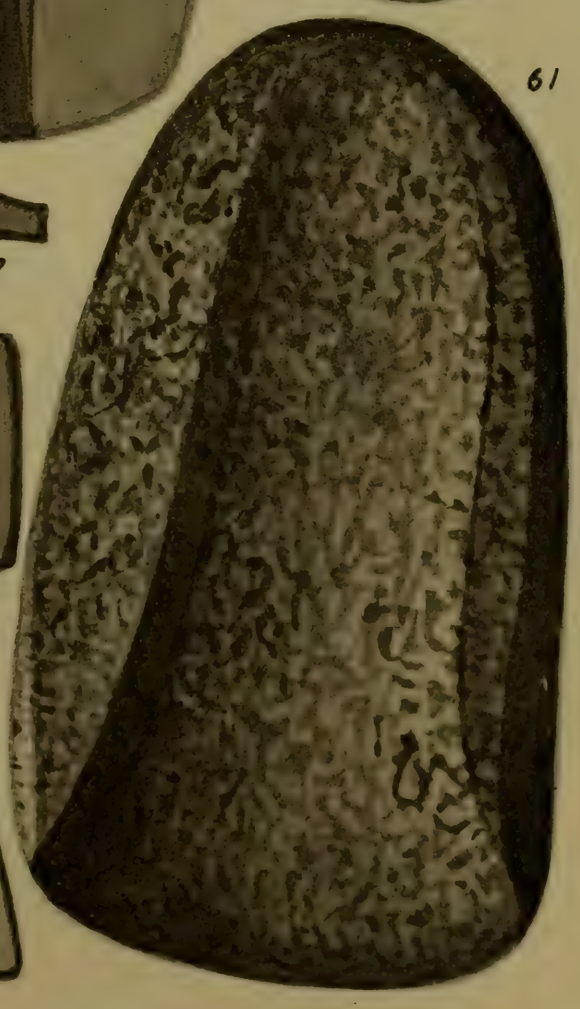

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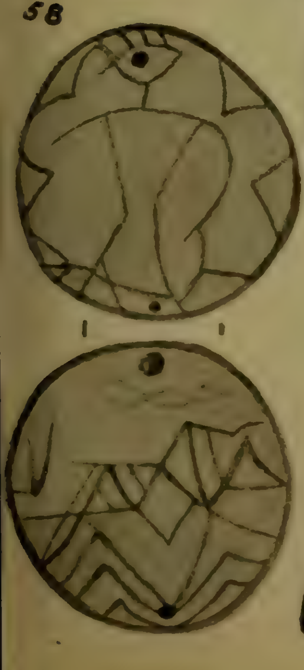

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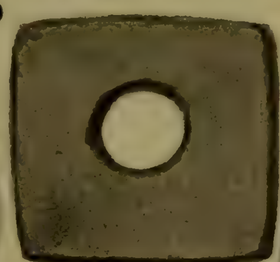

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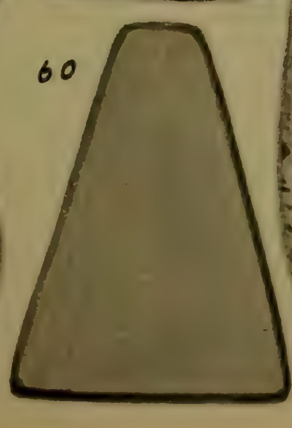

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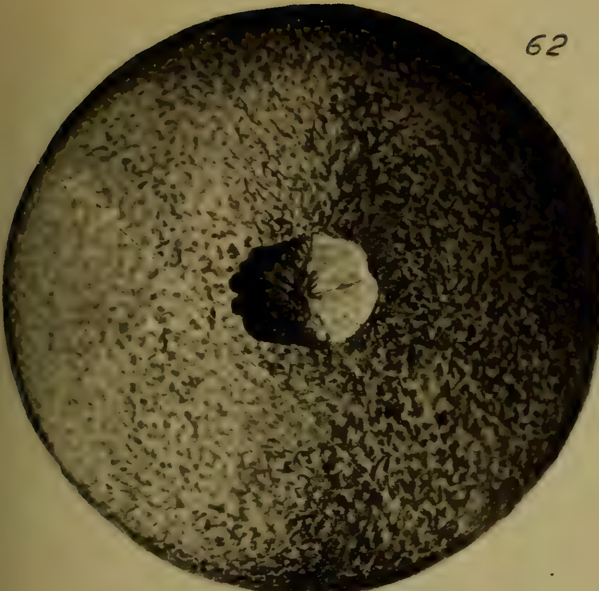

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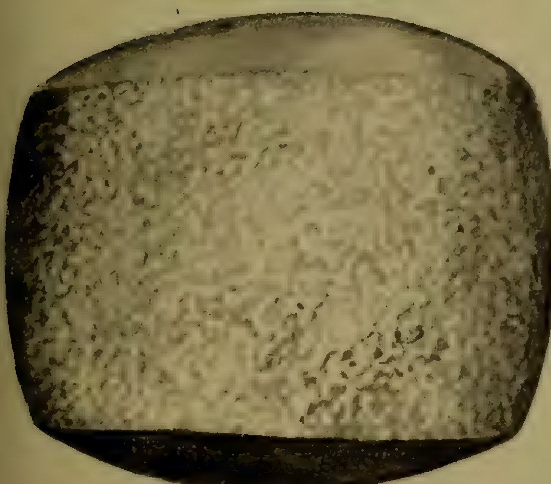

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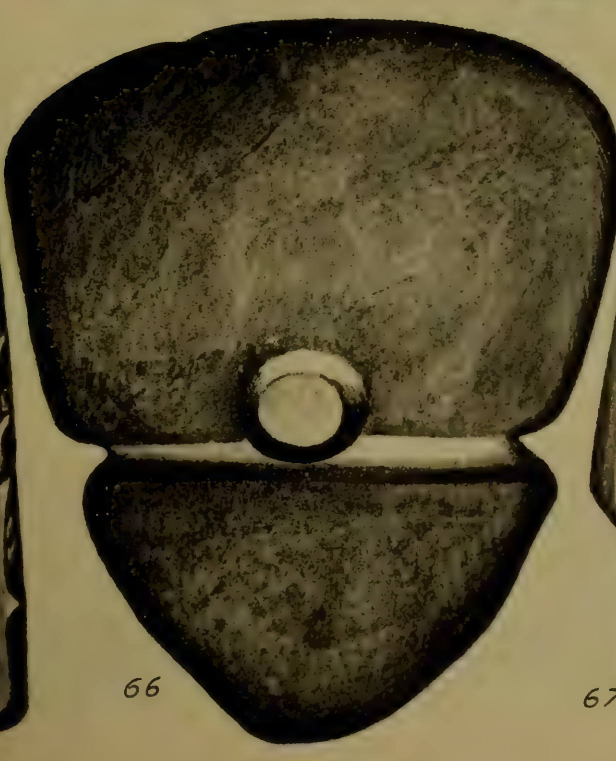

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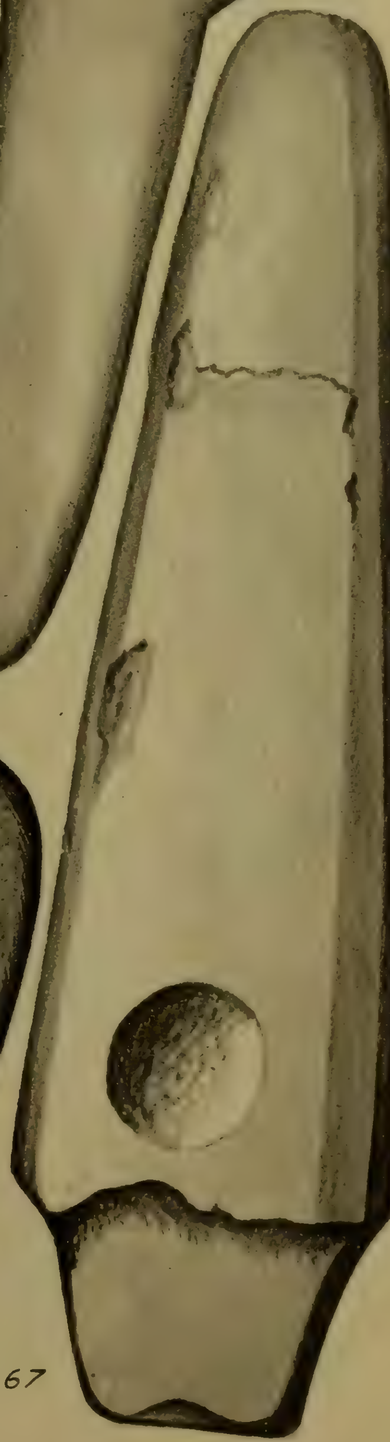

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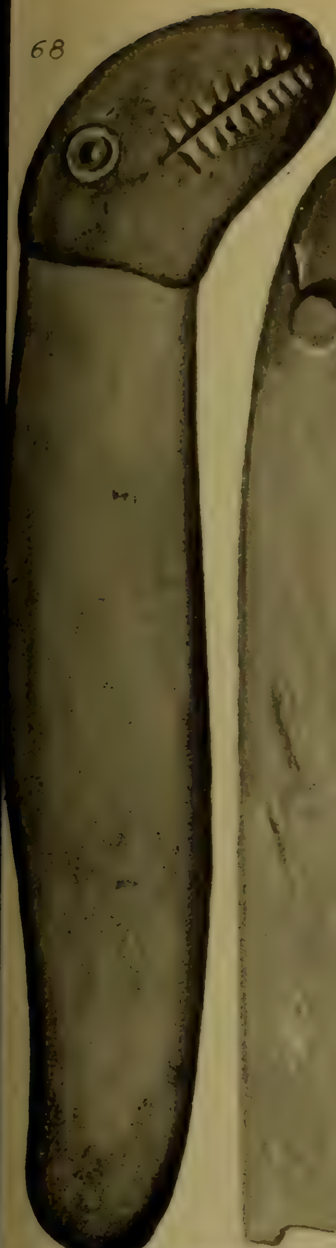

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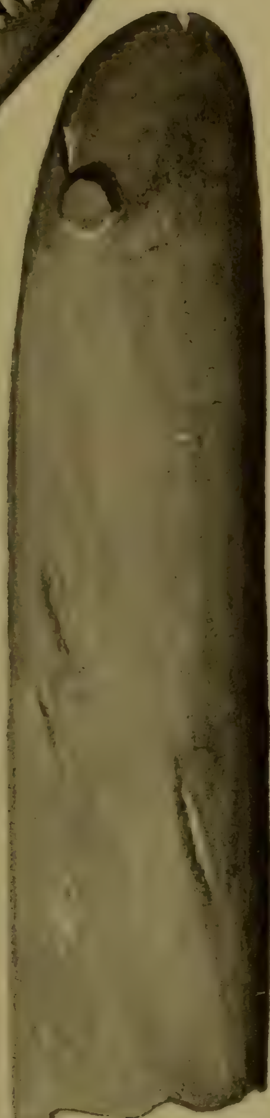

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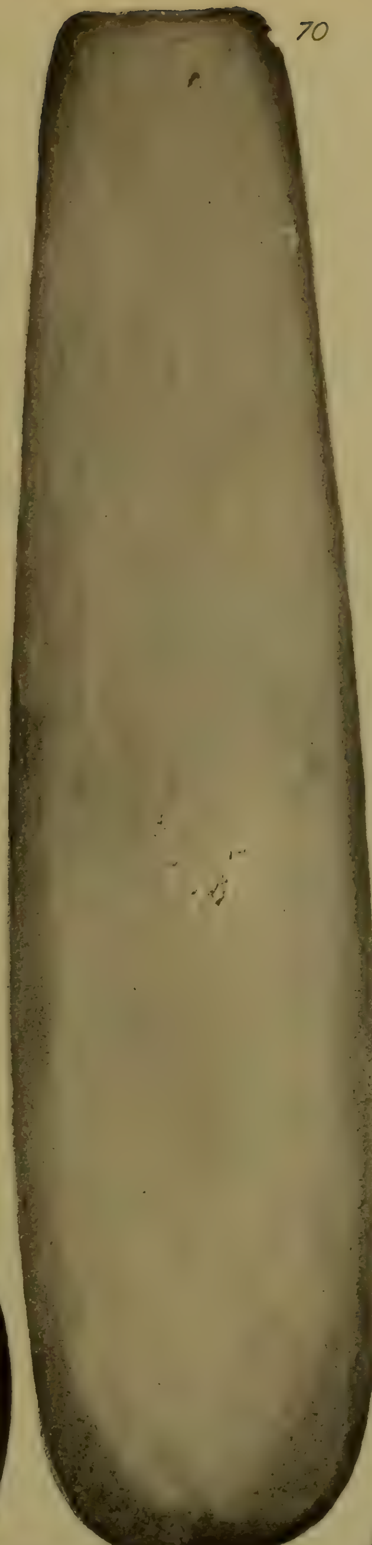

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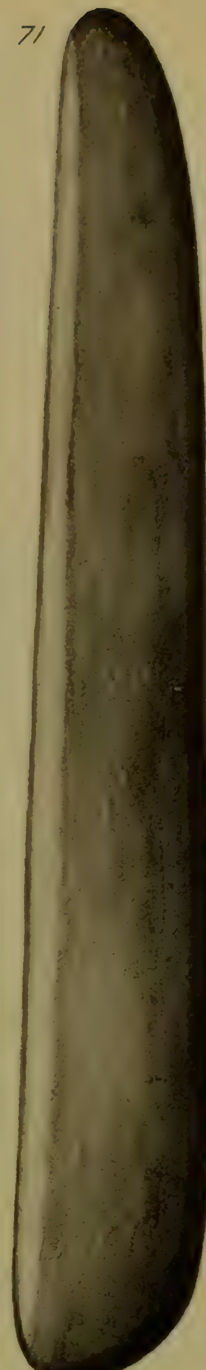

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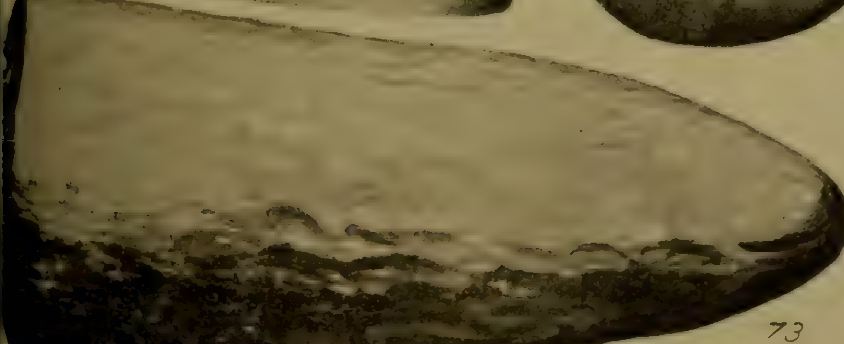

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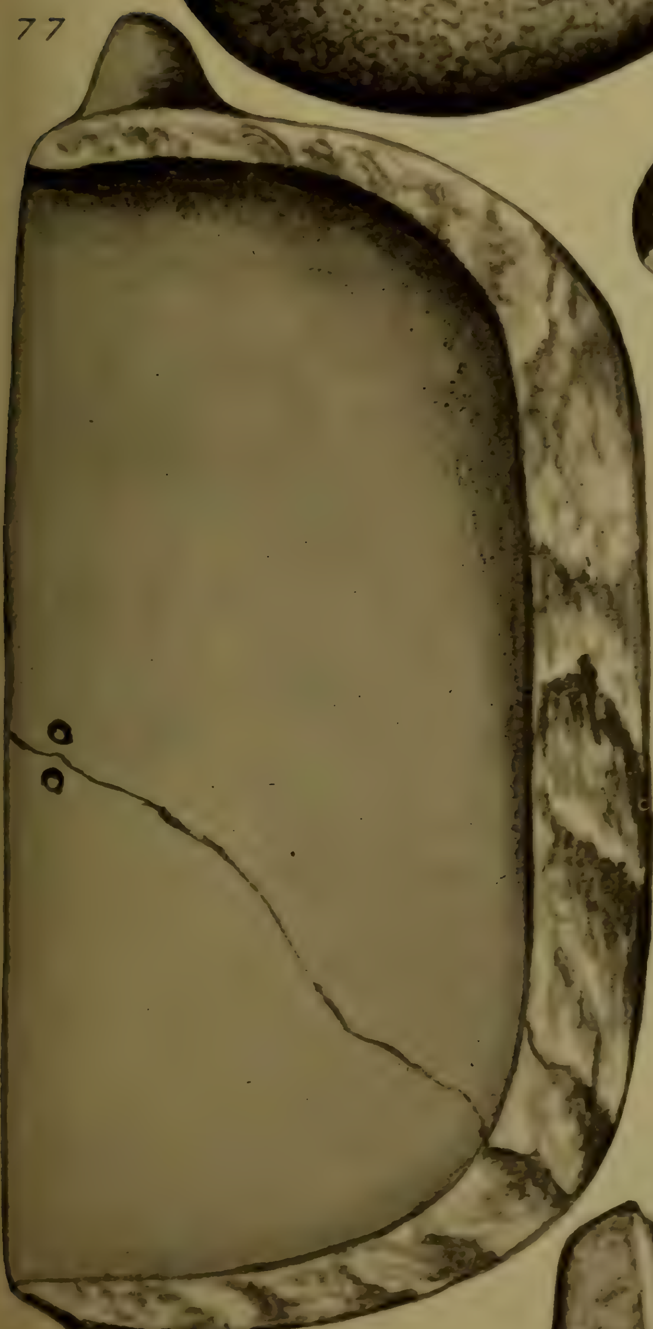

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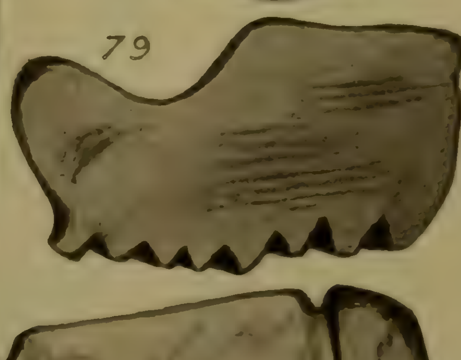

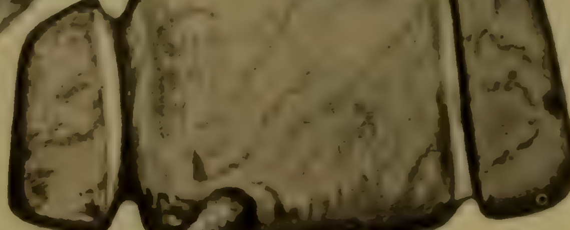

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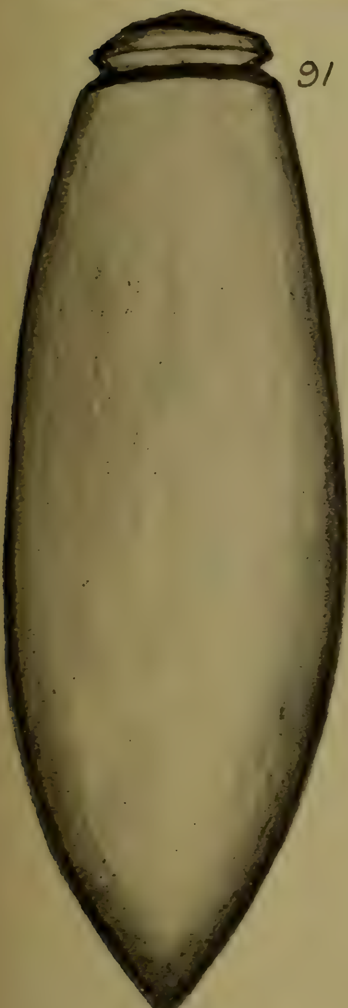

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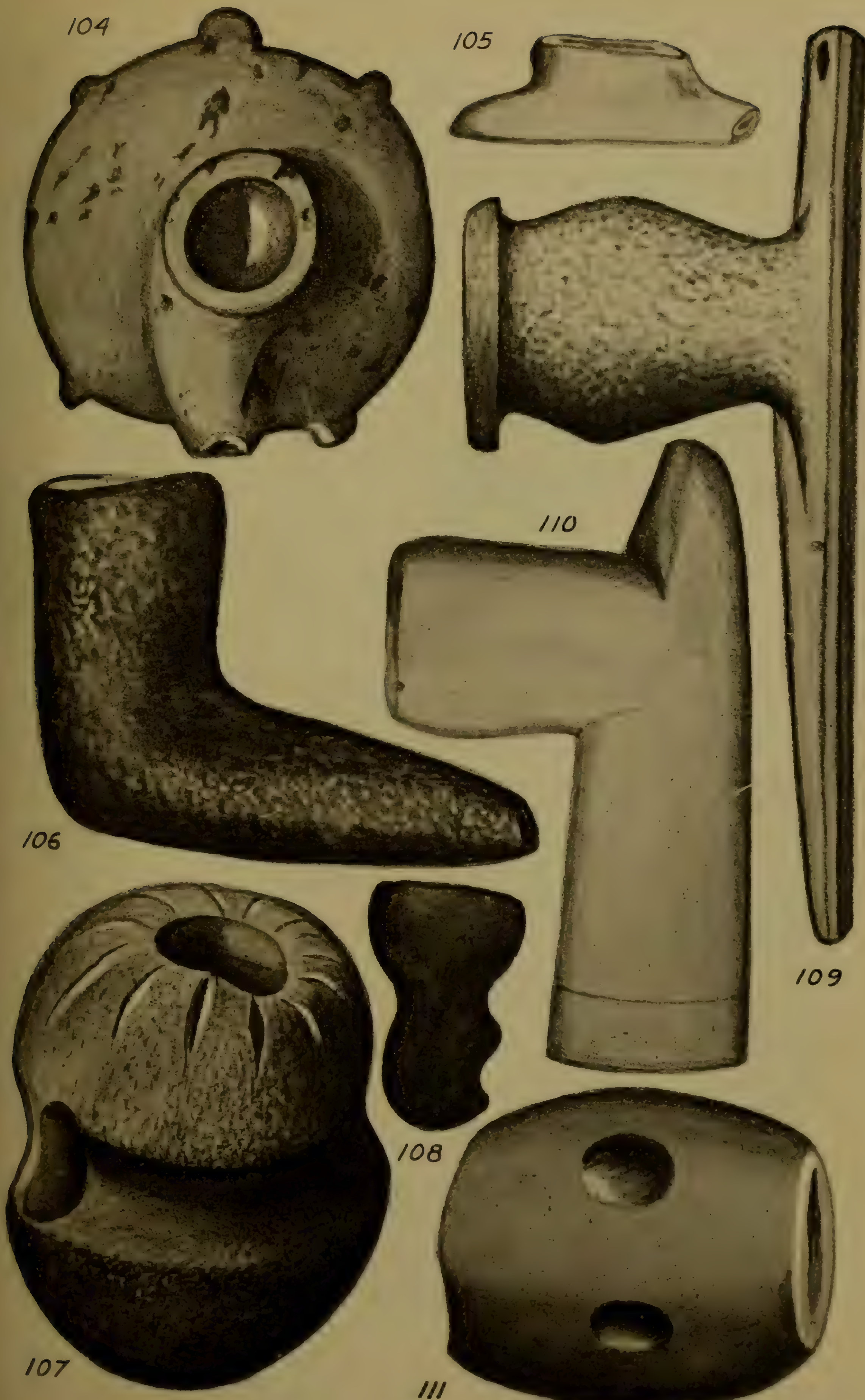
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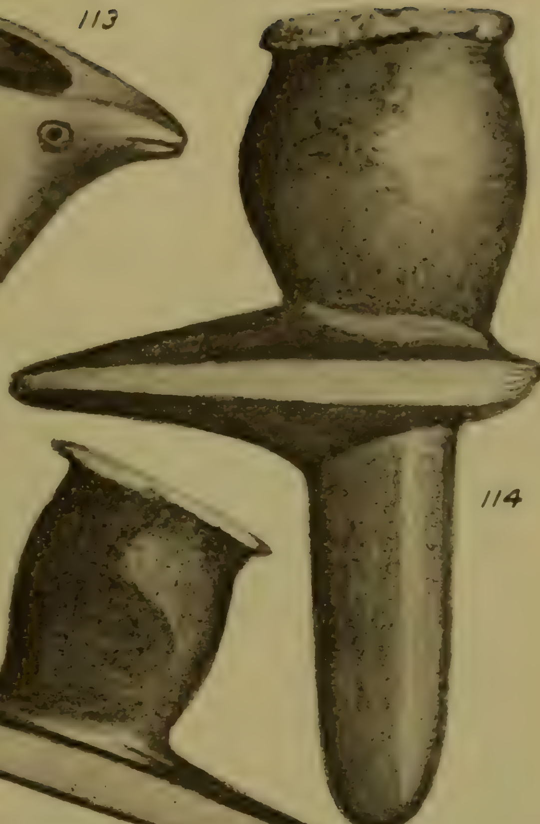
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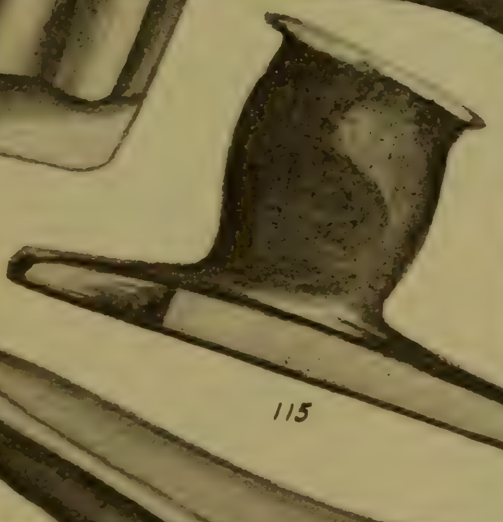
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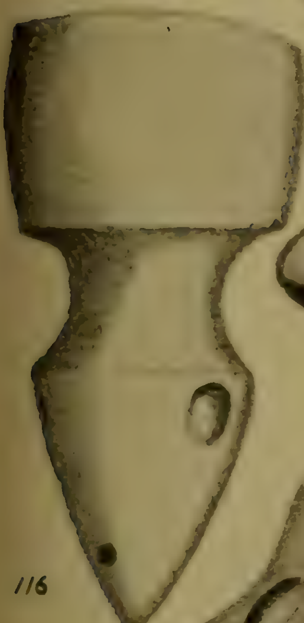
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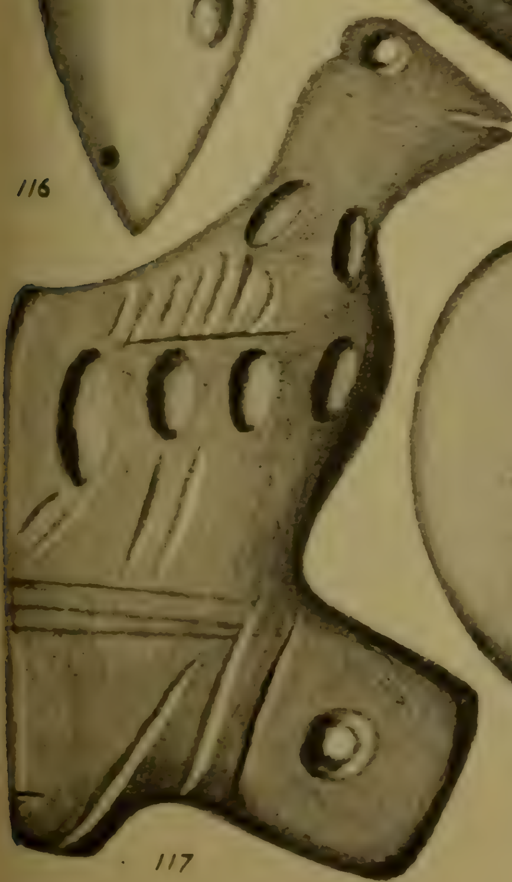
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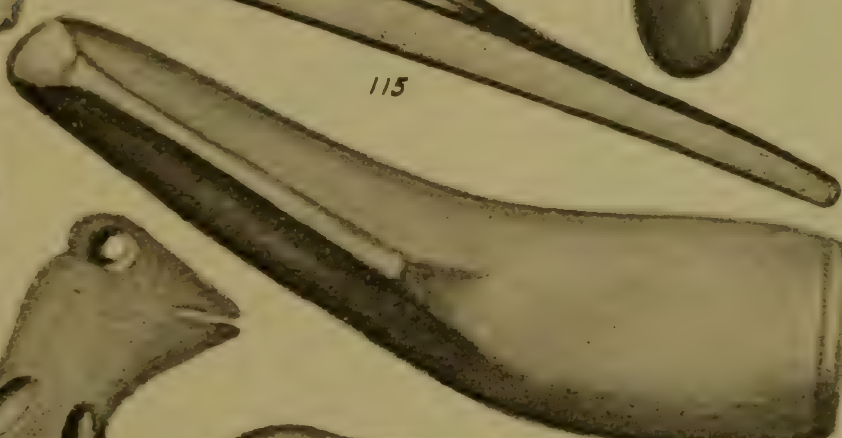
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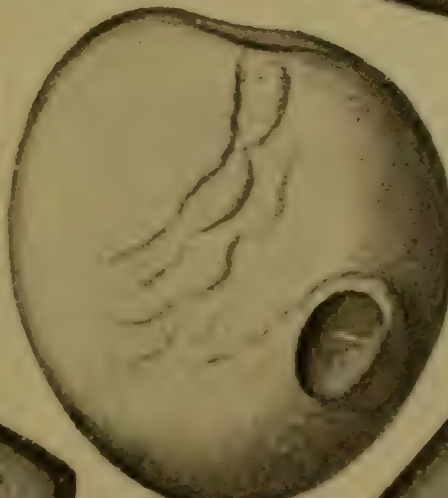
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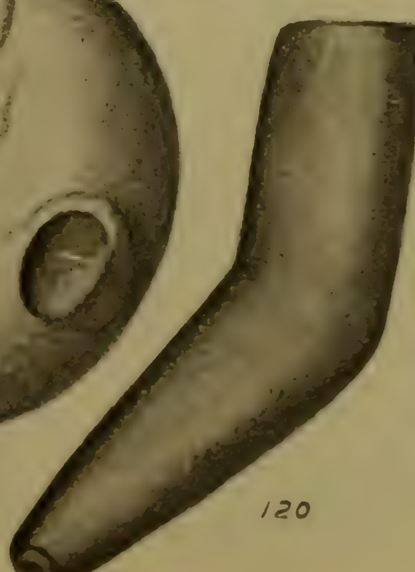
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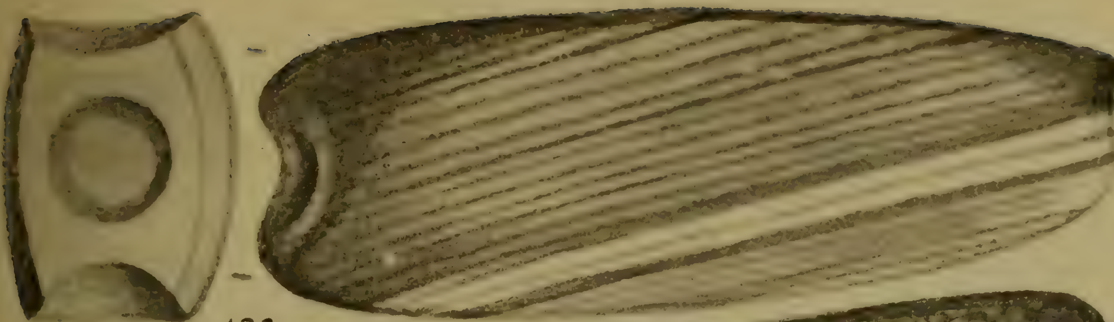
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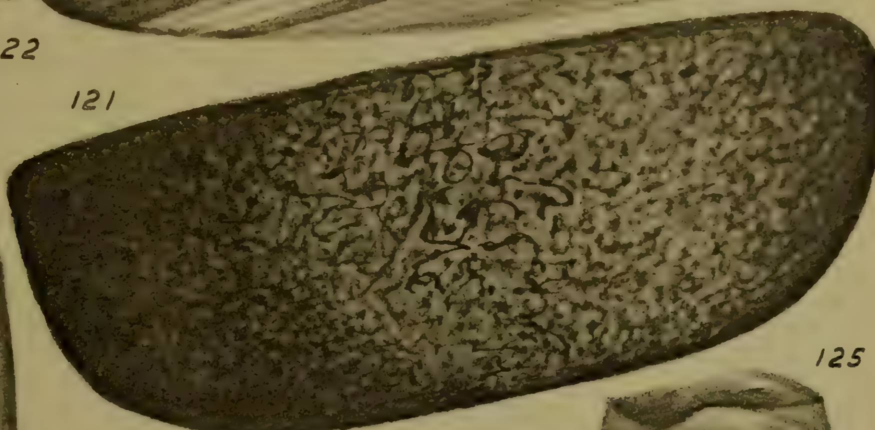

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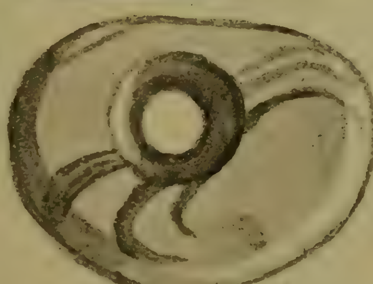

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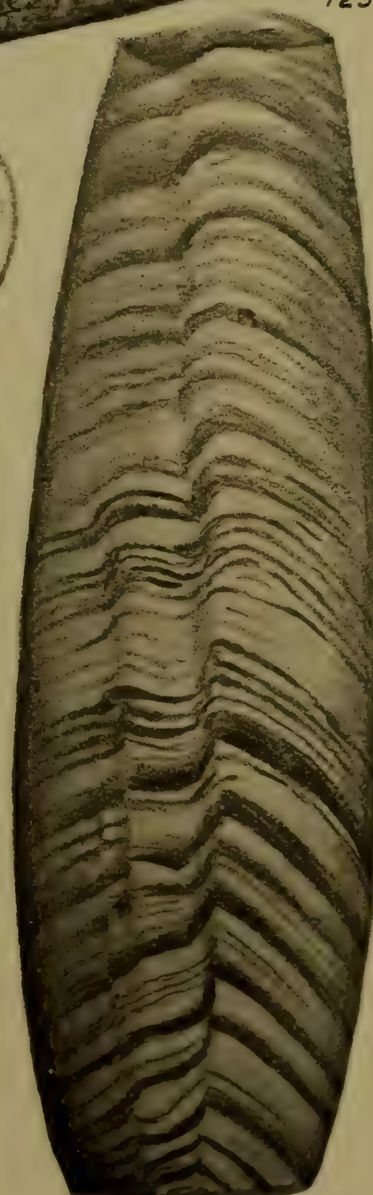

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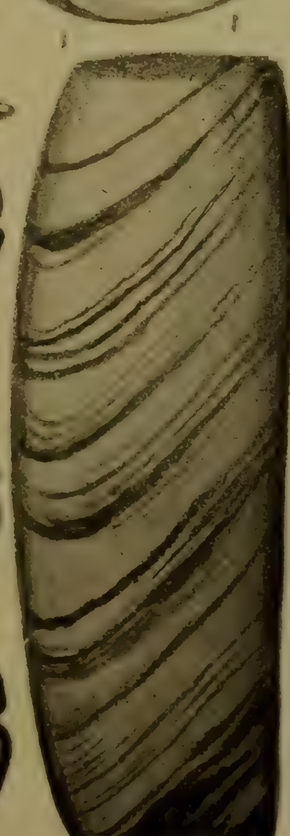

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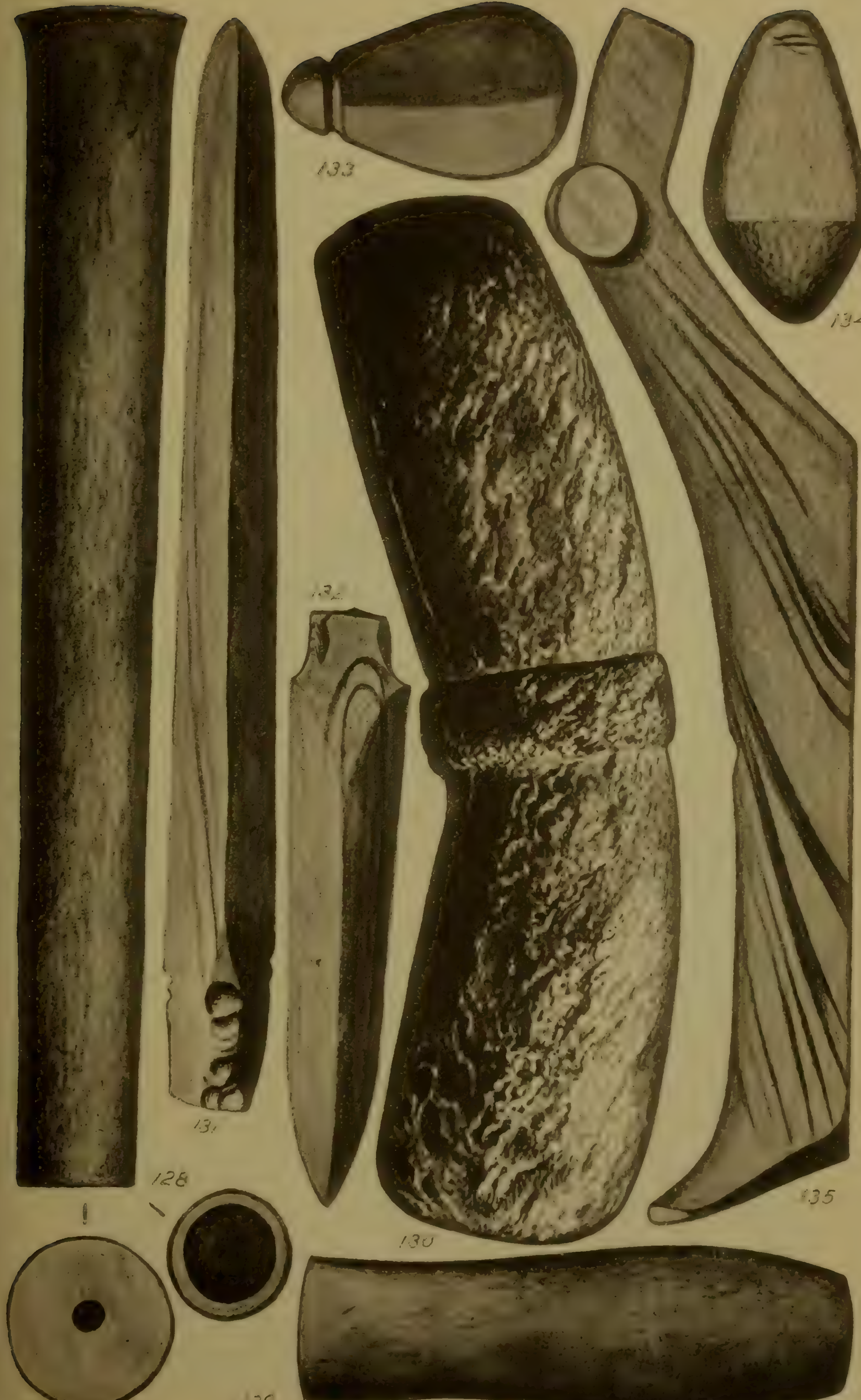
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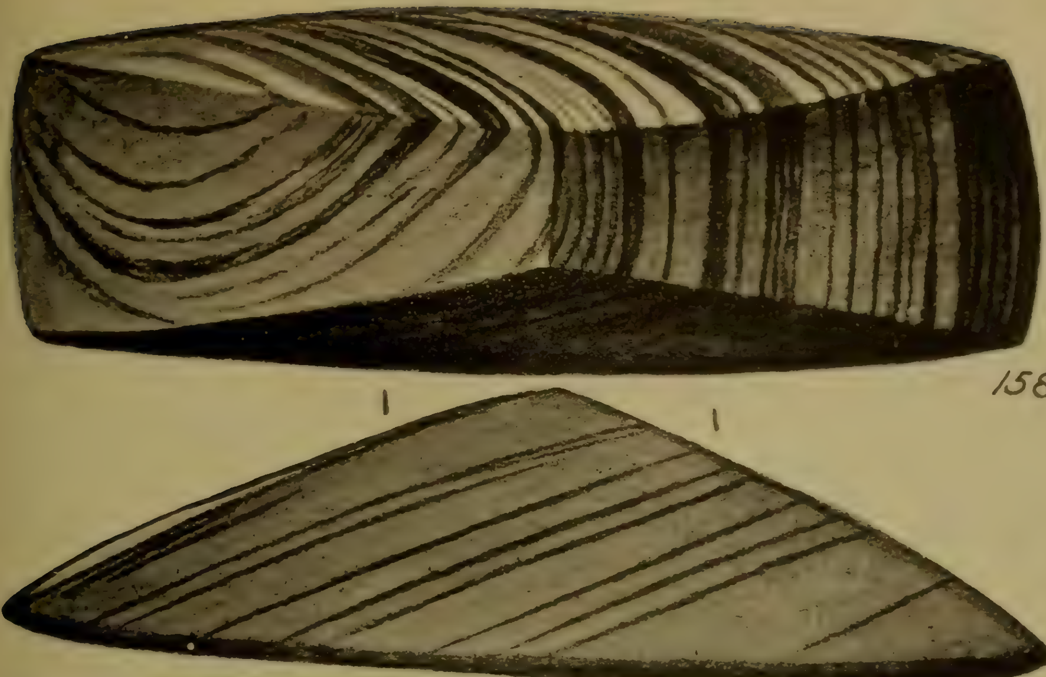

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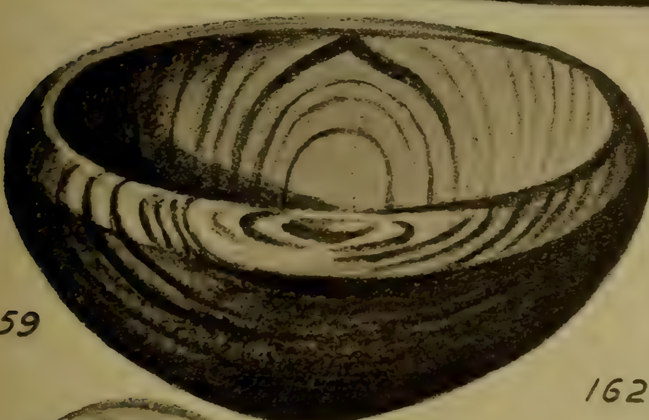

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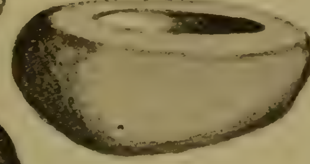

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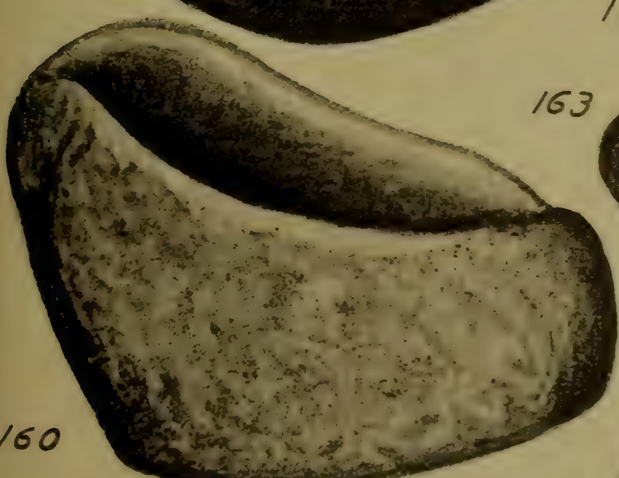

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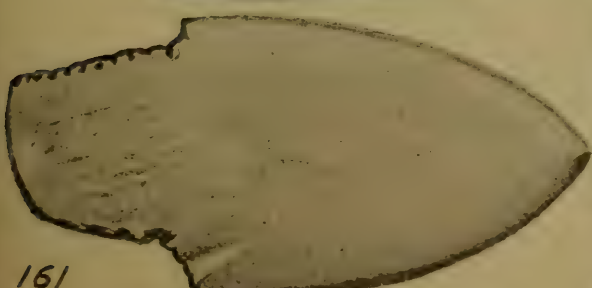

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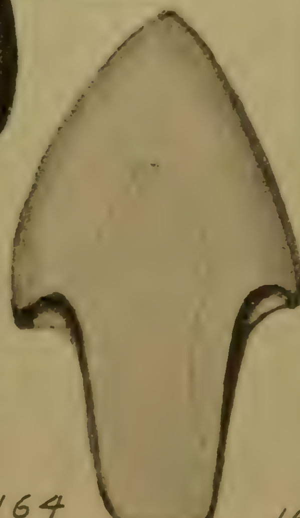

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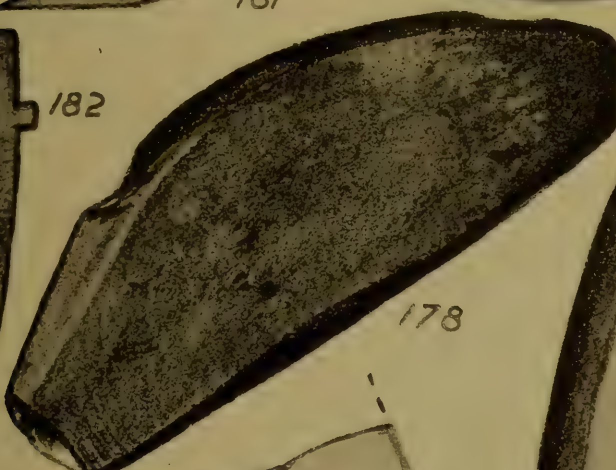

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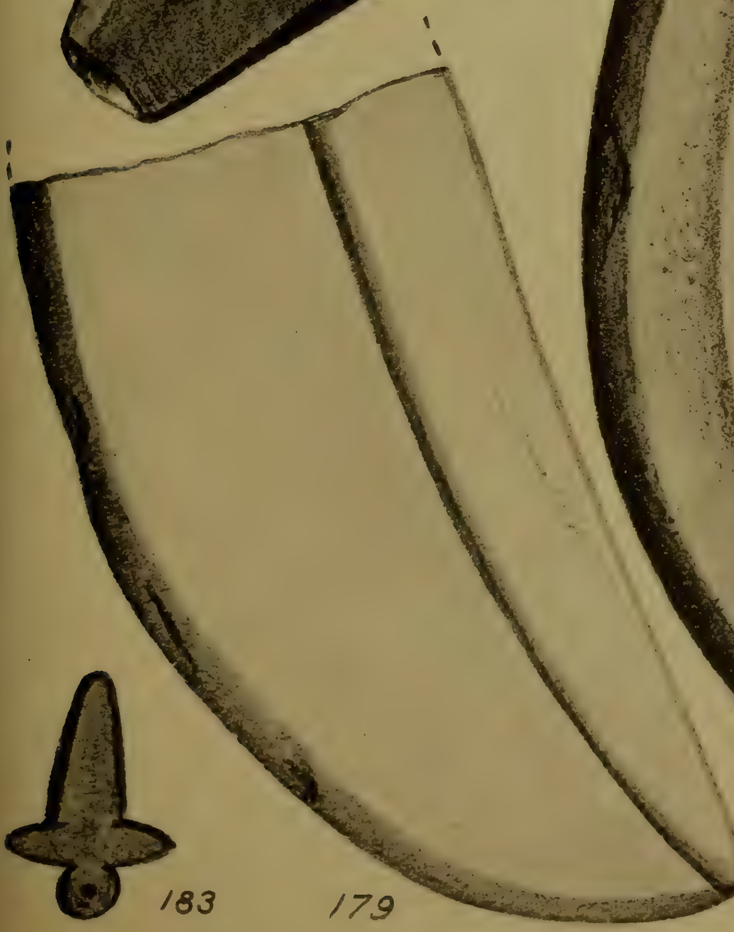

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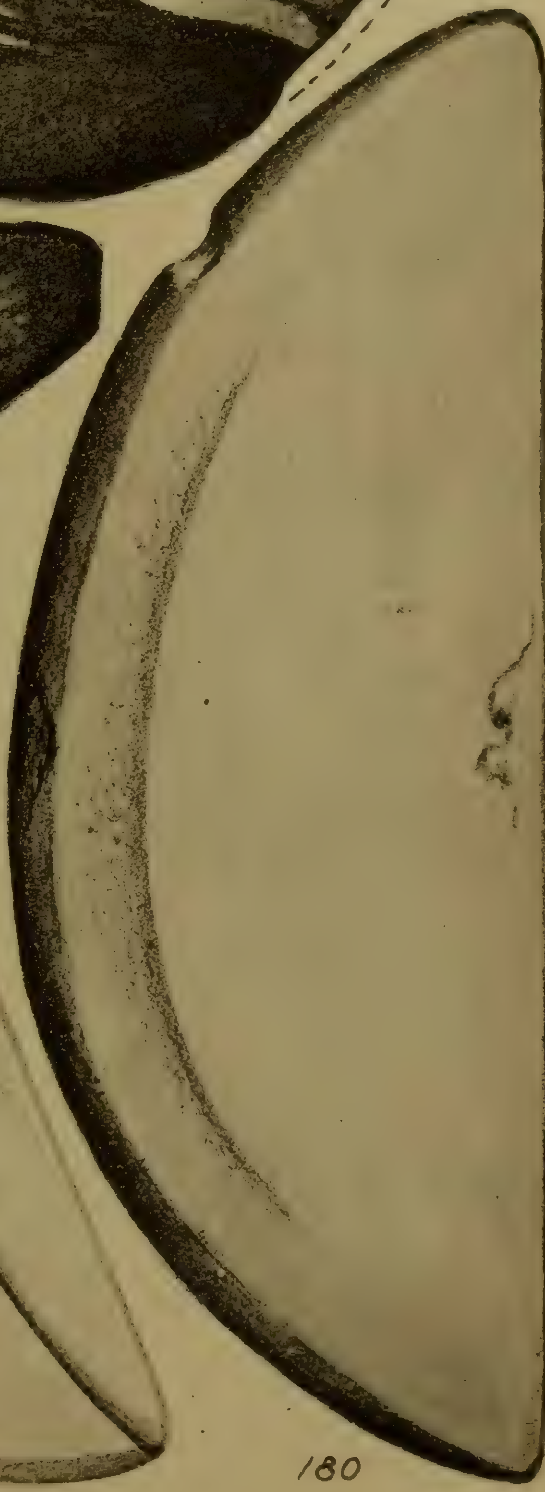

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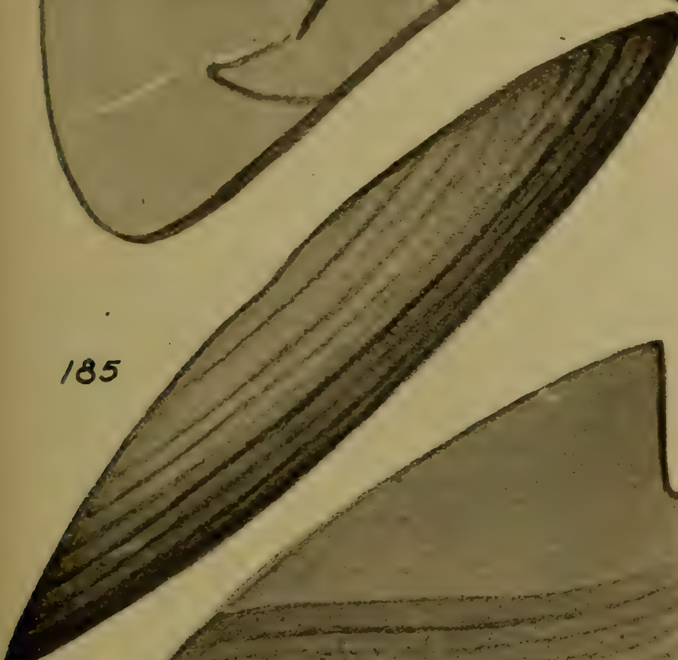

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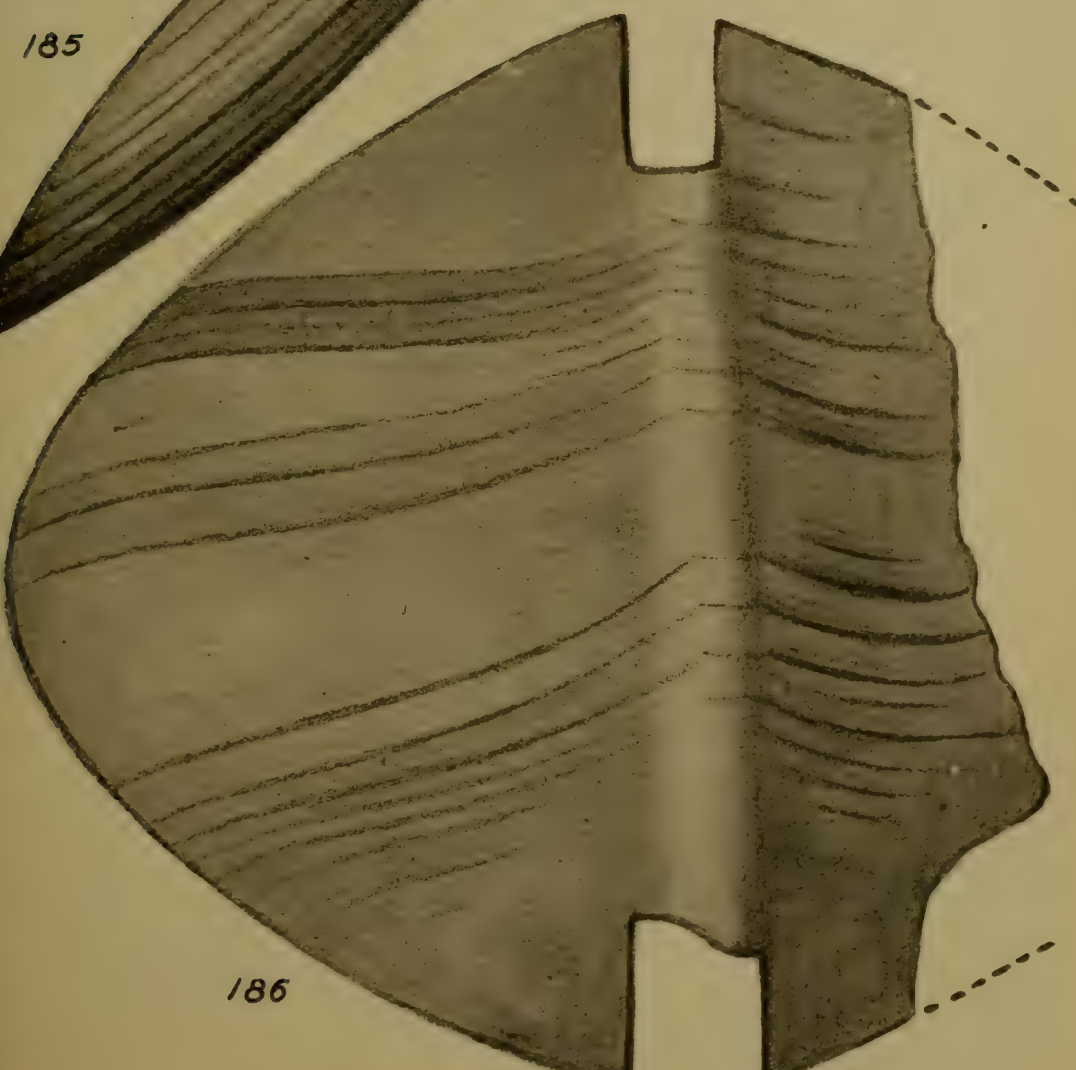

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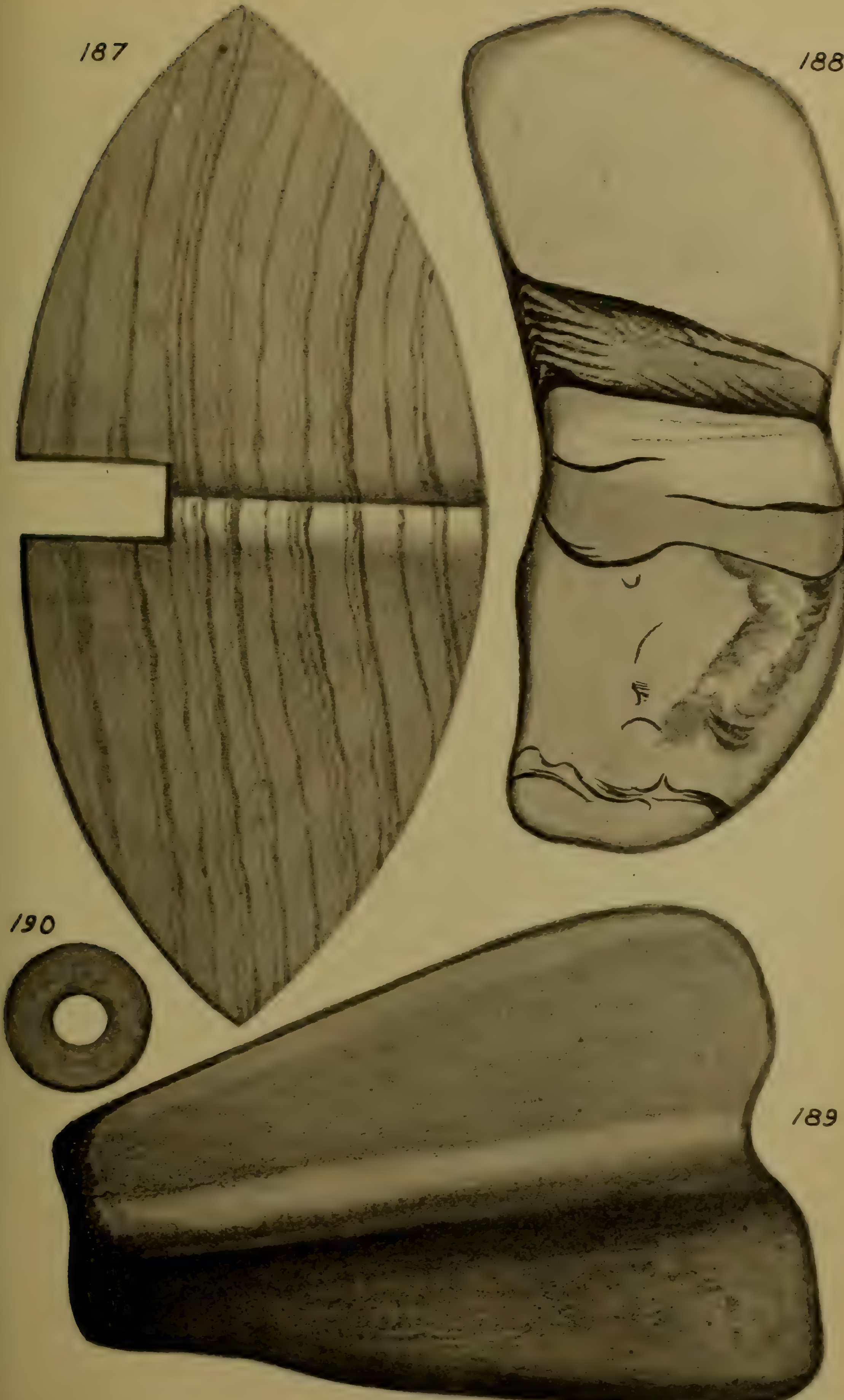

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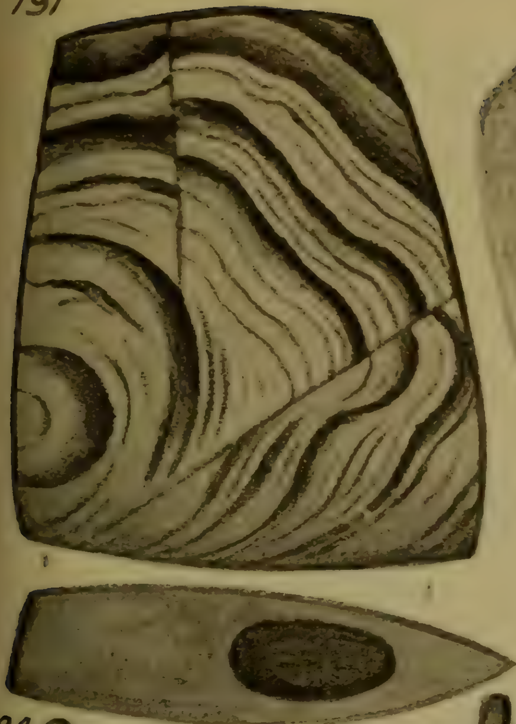

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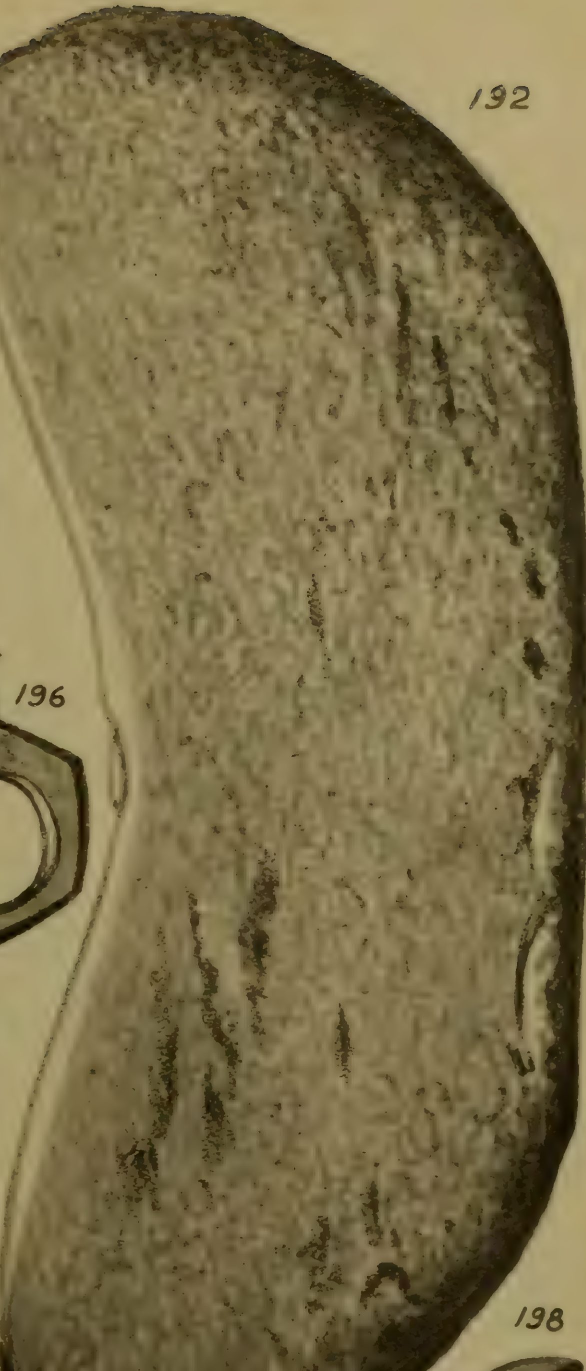

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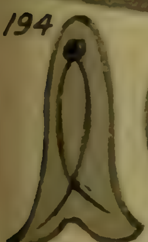

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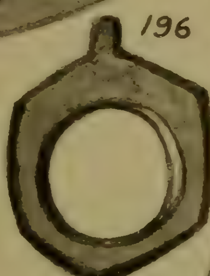

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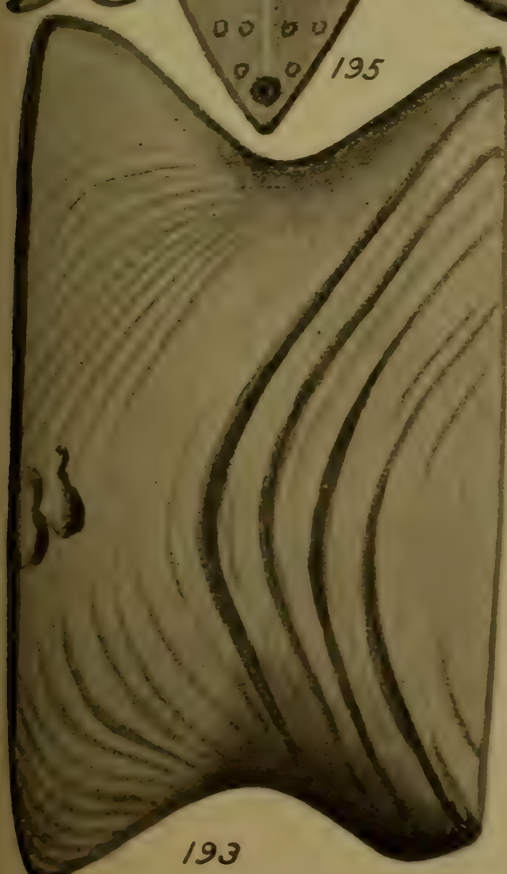

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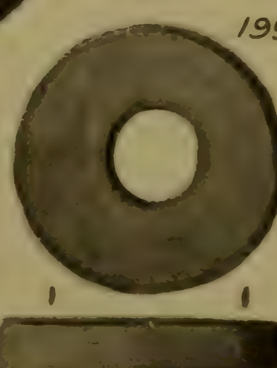

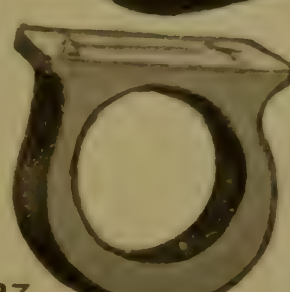

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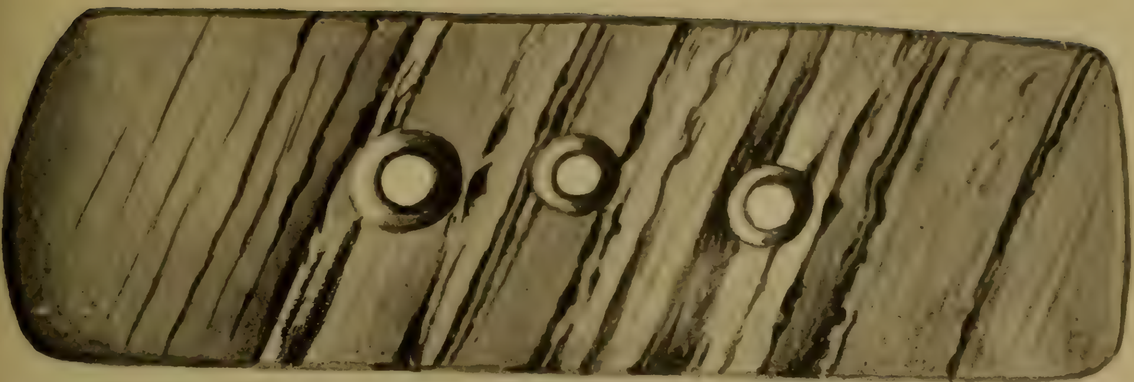

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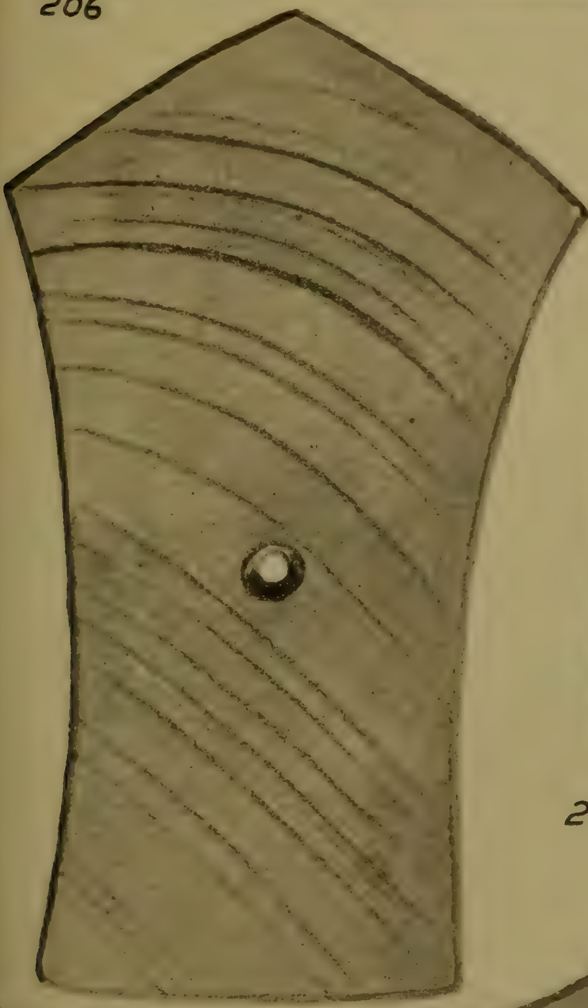

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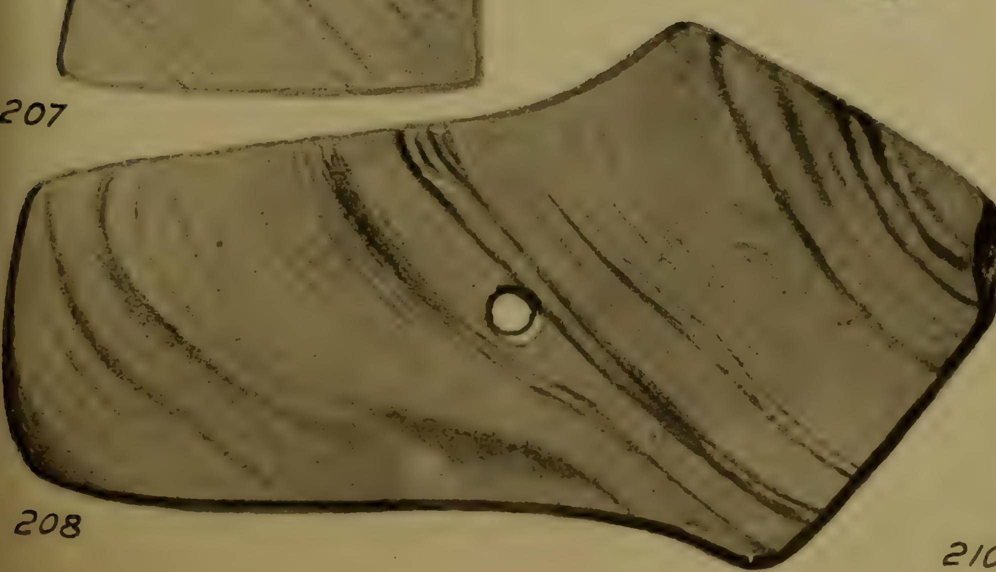

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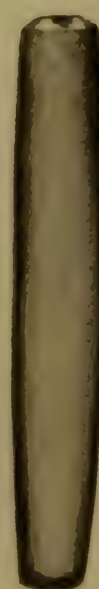

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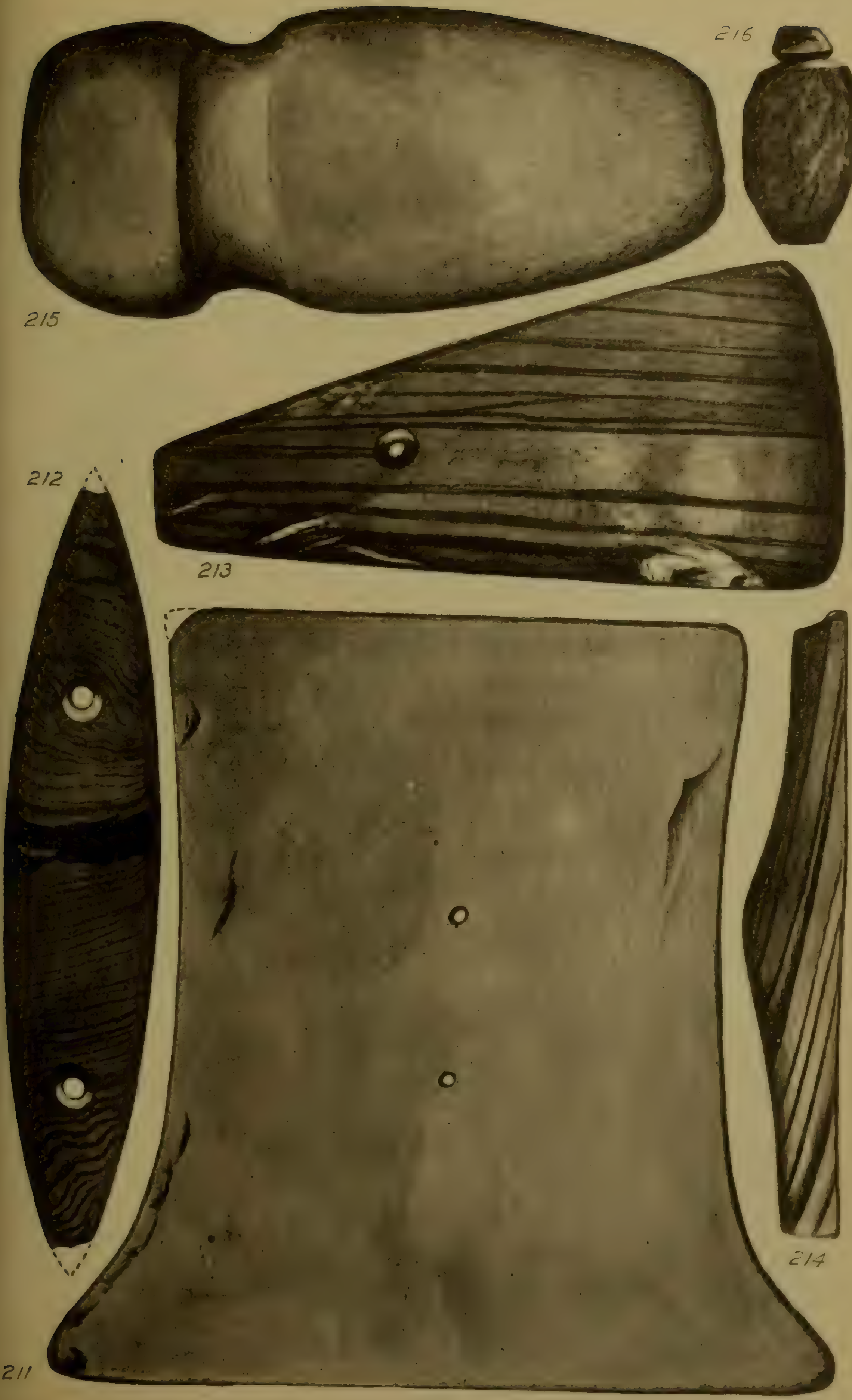
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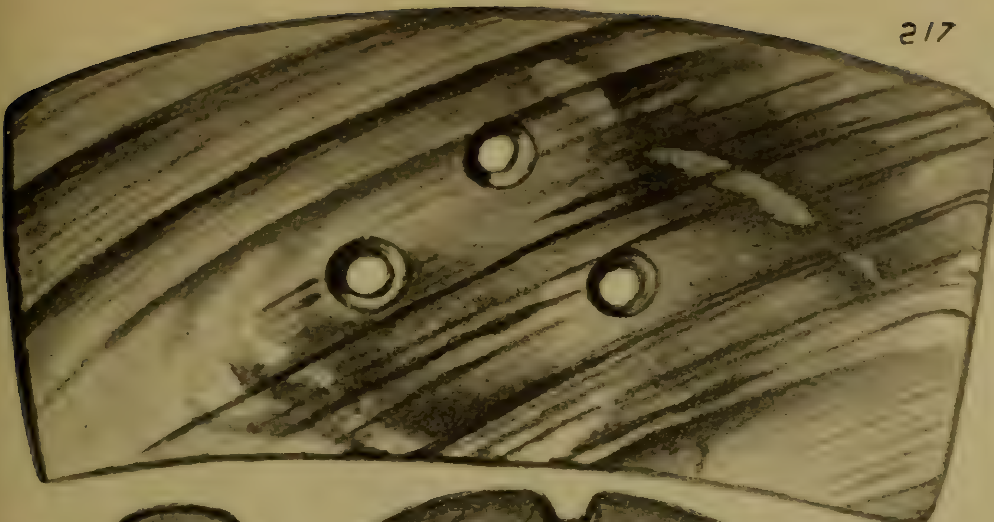

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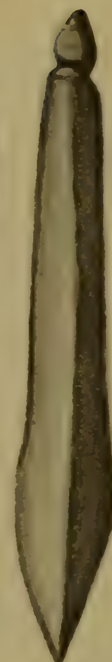

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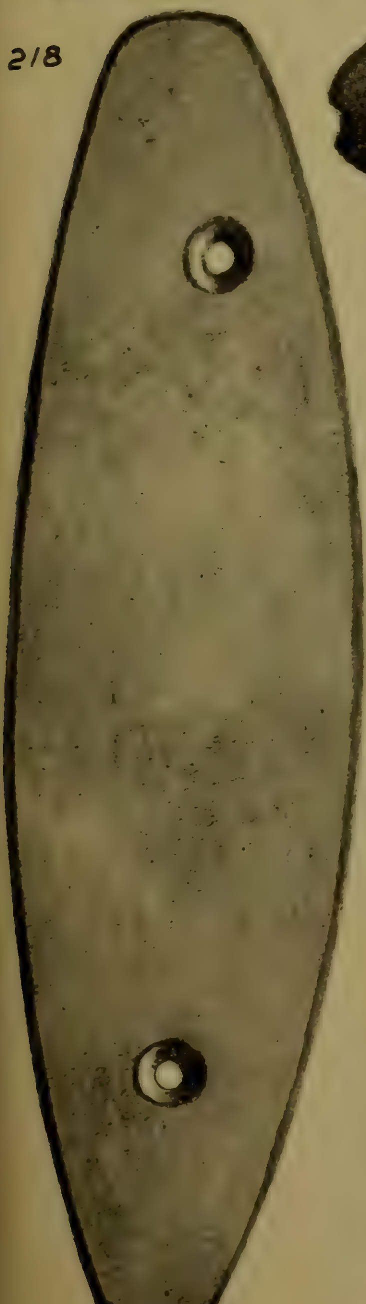

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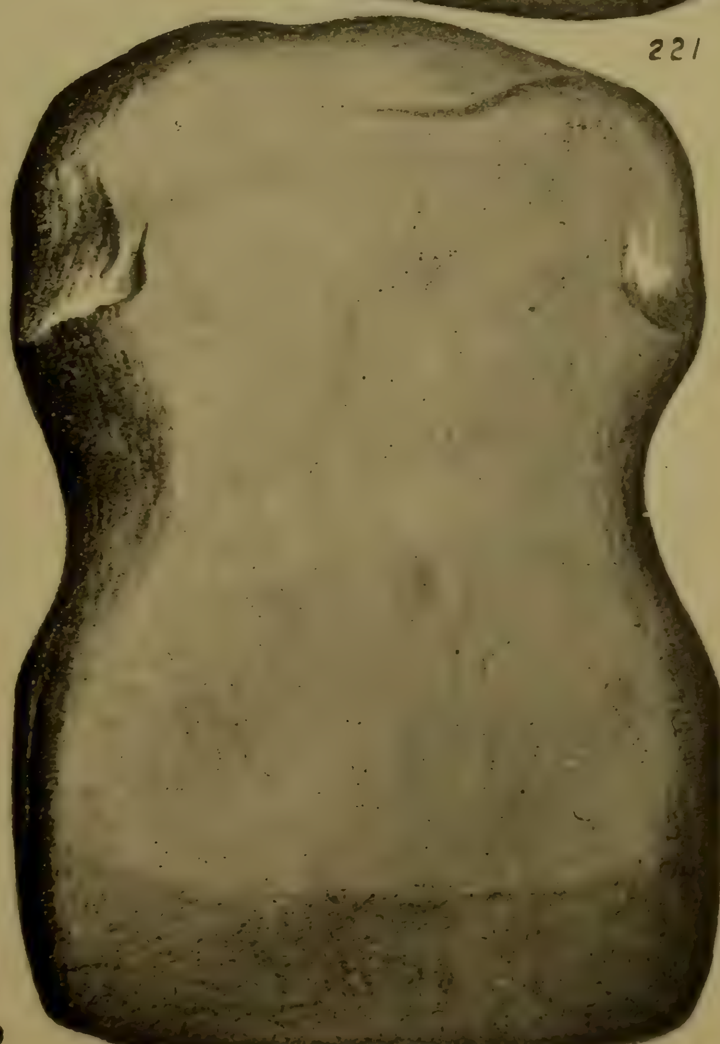

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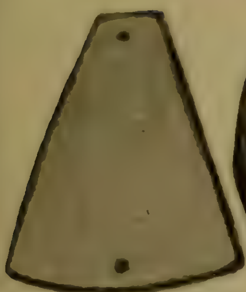
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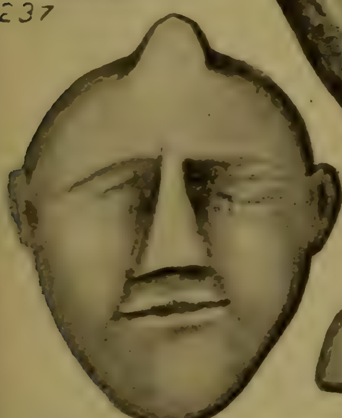
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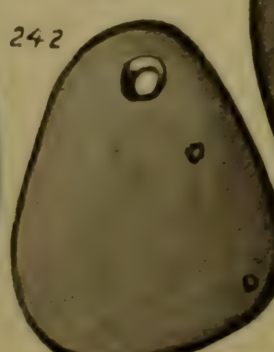
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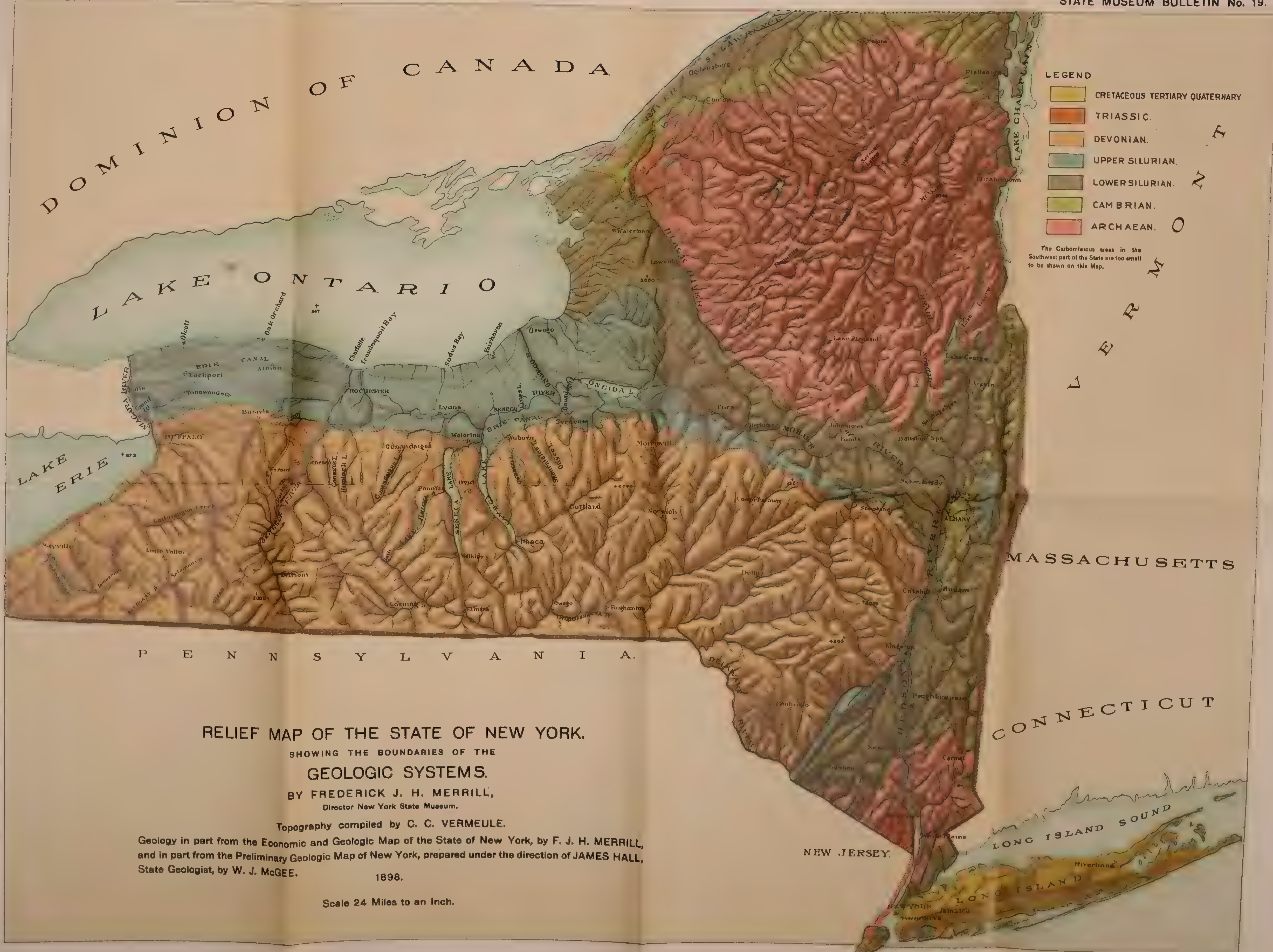

RELIEF MAP OF THE STATE OF NEW YORK.
SHOWING THE BOUNDARIES OF THE
GEOLOGIC SYSTEMS.
BY FREDERICK J. H. MERRILL,
Director New York State Museum.
Topography compiled by C. C. VERMEULE.
Geology in part from the Economic and Geologic Map of the State of New York, by F. J. H. MERRILL, and in part from the Preliminary Geologic Map of New York, prepared under the direction of JAMES HALL, State Geologist, by W. J. McGEE.
1898.
Scale 24 Miles to an Inch.

University of the State of New York

BULLETIN

OF THE

New York State Museum

VOL. 4 No. 19

NOVEMBER 1898

A GUIDE TO THE STUDY OF THE

GEOLOGICAL COLLECTIONS

OF THE

NEW YORK STATE MUSEUM

BY

FREDERICK J. H. MERRILL, PH. D., *Director*

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1898

University of the State of New York

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PREFACE

It has been the experience of the Director of the State Museum that a majority of the visitors to the Geological Hall have not had the advantage of an elementary training in geology and therefore do not obtain from the collections such information as they might receive if they fully understood their purpose and value. This statement applies both to the majority of the adult visitors and to the pupils of the various schools who, with their teachers, visit the geologic collections every year. With this fact in view, it seemed important to prepare a Guide to the Study of the Geologic Collections which could be sold at a nominal price and therefore placed within the reach of all who might need it.

As the function of a geologic museum is to aid in the study of geology, the purpose of this guide is to supplement the collections with such general information as cannot be given by cabinet specimens and to direct the visitor to reliable sources for more detailed information.

In 1861, Mr. Ledyard Lincklaen prepared, by direction of the Regents of the University, a *Guide to the Geology of New York and to the State Geological Cabinet*, which was published in the Fourteenth Annual Report of the State Cabinet of Natural History. This report being now out of print and Lincklaen's 'Guide' having been of much use in its day, though now obsolete in many respects, it seemed desirable to replace the latter so far as possible by the preparation of a new guide to the study of the collections.

In this undertaking the attempt has been made not so much to write a new book as to put into convenient form all information necessary to the purpose in view.

In the following pages the general arrangement is similar to that adopted in most of the geologic text books. The introductory matter is newly written and also the larger portion of the chapters on the Archaean and Cambrian rocks. The Cambrian below the Potsdam was not known as such in Lincklaen's time and was not discussed by him. The description given herewith is taken chiefly from the work of C. D. Walcott, Bulletin of the U. S. Geological Survey No. 81. The Palaeozoic strata of New York from the Potsdam to the Catskill were well known to the members of the original geological corps, Hall, Mather, Emmons and Vanuxem and Lincklaen's interpretations of their published results were so satisfactory that in the present work his descriptions of these formations have been used, so far as practicable, with such corrections and additions as were necessary to express our present knowledge.

In making these corrections, the statements of the original corps of geologists and of the later geologists who have worked in New York have been freely quoted.

The descriptions of the Mesozoic and Cenozoic ages have been newly written.

Lincklaen's descriptions of the fossils of New York are not wholly accurate in the light of modern knowledge and in order to save time in revision and the considerable space needed for a proper presentation of the subject, they have been omitted. References are, however, given to the proper authorities and it is hoped that the State Palaeontologist may prepare a handbook on this important subject.

The chapter on economic geology is abridged from Bulletin 15 of the New York State Museum, with some additions.

The illustrations are, to a large extent, new and it is believed that the representation of typical sections and exposures by photographs is more satisfactory than by the more common diagrams.

It is to be regretted that it was not possible to make a series of photographs complete in each geologic series, but no opportun-

ity was afforded for this. The photographs of Dr. Heinrich Ries and Prof. I. P. Bishop were chiefly made for the New York State Museum. The photographs by N. H. Darton are from the collection of the Geological Society of America, and printed through the courtesy of the United States Geological Survey; many of these have already appeared in the report of the State Geologist. The remainder have been secured from various sources.

For many of the general statements concerning the ages and systems acknowledgment is made to the writer's late friend and teacher Dr. John S. Newberry.

To Prof. James Hall, State Geologist, the writer is indebted for numerous facts and conclusions concerning many of the Palaeozoic strata of New York.

As it seemed desirable to provide a pamphlet which could be distributed at cost price to all visitors to the museum who were interested in the study of the collections, the bulletin has been made as small as possible, but it has much outgrown the dimensions originally contemplated.

Since the geologic collections of the New York State Museum are not yet in a state of final arrangement, no detailed reference is made in this bulletin to the museum cases, but the system of labelling adopted is such as to make it an easy matter to refer from the guide to the museum specimens.

It is hoped that this bulletin may, in its function as a guide and supplement to the geologic collections of the State Museum, prove a useful aid to beginners in geology. It aims, through its text, to place within the reach of those interested, a brief synopsis of the geology of the state, and by its illustrations made from photographs, to show the exact appearance of many typical exposures. It is hoped that its readers will receive from it a general idea of the New York formations and will be led to supplement by detailed study of local geology the valuable general text-books accessible to all.

It is assumed that the student before taking up geology has had a good general training in physics and chemistry, without which no proper understanding of the subject can be had. An elementary knowledge of zoology and botany is also indispensable.

FREDERICK J. H. MERRILL

Albany, N. Y.
January 1, 1898

PART 1.

THE SCIENCE OF GEOLOGY AND ITS HISTORY

Geology includes all knowledge of the origin, history, composition and structure of the earth.

Before commencing to discuss geology in its present state of progress, it is desirable to consider briefly its history as a science.

The origin of the world was a matter of interest to the earliest Oriental philosophers no less than to the sages of Greece, and the speculations of these early leaders in thought seem to indicate the possession of some accurate knowledge, but we must date the beginning of geologic science from the period when geologic phenomena were first observed and correctly interpreted. For a record of these earliest geologic studies we are mainly indebted to the industry of Sir Charles Lyell.[a]

Geology began, about 1000 B. C. with the Egyptian priests who observed that the limestones bordering the valley of the Nile had been cut through by erosion and that marine fossils were exposed. In the sixth century B. C. numerous observations on terrestrial changes are ascribed to Pythagoras, and Xenophanes is said to have observed and mentioned the occurrence of various fossils. Aristotle and others in their writings speak of fossil fishes. Attention was also called by Aristotle to the changing distribution of sea and land in certain localities. From that time to the Christian era, history affords many records of observations on geologic phenomena but no attempt was made to reason from the present to the past or to do more than recognize terrestrial changes contemporaneous with man.

Some Arabian writers of the 10th century A. D. are credited by Lyell with accurate observations on the origin of mountains and certain changes of sea level, but not till the 16th century

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[a] *Principles of Geology*

did Christian nations give any attention to geologic phenomena, and one of the first men to appreciate and assert the true origin of fossils was Leonardo da Vinci, the famous painter. In his time, public sentiment, influenced by monastic teachings, was so biased that persons who held the opinion that fossils were the remains of living forms, were subjected to persecution. The orthodox view then was, that fossils were freaks of nature produced by the influence of the stars and other mysterious agencies. As various religious interests were supposed to be jeopardized by the more scientific deductions, much animosity was aroused by them.

After 100 years wasted in fruitless discussions on the source of fossil forms, in the beginning of the 18th century the theory occurred to some that the shells which were found in the rocks were relics of the Noachian Deluge and consequently the idea of their organic origin was adopted by many as a confirmation of Biblical history. This new hypothesis lasted for nearly 150 years and those who dared to assert their disbelief in it were exposed to persecution as unbelievers in the Holy Scripture.

During the last half century an invincible array of facts has been developed by diligent scientific workers of many nations in geology, biology, physics, chemistry and astronomy. These facts have been classified into the science of to-day.

ORIGIN OF THE EARTH AND ITS CRUST

The history of the origin of the earth is not found in the study of the earth itself.

Geologic history, properly speaking, begins with the period of the earliest geologic record. But no portion of the first solid crust of our globe is known to be exposed to view nor does it seem likely that any portion of it will ever be revealed. From the kindred sciences of physics, chemistry and astronomy, in many ways, we obtain light upon the origin of the earth prior to the commencement of the geologic record.

The earth is to man, one of the two most important members of a group of celestial bodies held in relation to each other by gravitation, which we call the solar system. The center of this system is the sun, about which revolve the planets with their satellites and the planetoids, and without which as a source of light and heat, no life could exist on earth.

To explain the origin of the solar system the *Nebular hypothesis*[a] was suggested by Swedenborg and Kant and elaborated by Laplace. Although not completely proven it is highly plausible, and answers most of the conditions. According to this hypothesis our solar system originated as a vast nebula, similar to nebulae which now exist, in the form of an immense volume of incandescent gas rotating in space from west to east, of which the limits extended beyond those of the present solar system which is about 5,500 millions of miles in diameter.

As this mass slowly parted with its heat and contracted in obedience to physical laws, its velocity of rotation would increase and in the peripheral or outer portion the centrifugal force would overcome the attraction toward the center, causing it to separate from the central portion in the form of a ring. This ring through unequal condensation would subsequently be broken, its fragments uniting by gravitation into a body revolving about the nucleus and ultimately forming a planet or in one instance a zone of small planets, that of the planetoids or asteroids. This process is supposed to have continued until the various members of the system were set free; the remnant of the much diminished but still intensely heated nucleus remaining as our sun which now has a diameter of 860,000 miles. The primary rings after condensing into planets are believed to have formed secondary rings which subsequently broke and became satellites, except in the case of Saturn which still retains two rings.

Inasmuch as some of the planets near the sun are denser than those more distant, it has been suggested that in the rotation of the primal nebula its components arranged themselves in lay-

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[a] See Young, *General Astronomy*, p. 515-25.

ers of different densities, the rarer substances to some extent occupying the outer portion of the mass.

If, as this hypothesis suggests, our earth is an integral part of the solar system we should expect to find its component elements in the sun and in the other heavenly bodies, and this expectation is confirmed by two distinct sources of information. Chemical analysis of the meteorites which fall to earth shows that these bodies contain many minerals which occur in the earth's crust[a] and that they do not contain any elements which are unknown on earth. Of late the application of the spectroscope to the study of the sun and stars has established the fact that these celestial bodies are largely composed of the elements already known on earth. There are however some lines in the solar and stellar spectra which are not matched by the lines in any terrestrial spectrum.

The conclusion to which we are led by the nebular hypothesis, viz.: that the earth originated as a rotating mass of incandescent gas, is corroborated by its present form, which is that of a spheroid of rotation or of a plastic body which, by rotation, has become flattened at the poles. The difference between the polar and equatorial diameters of the earth is about 27 miles.

Chemical science has established the fact that all forms of matter are composed of one or more of the elementary substances or elements, of which there are 74. These are all found either in the earth's crust, or in its atmosphere; they also occur in the sun, stars and other heavenly bodies. Most of these elements are very rare and do not come to the notice of the geologist. Only 11 are important as constituents of the earth's crust. These more common elements are given in the following table[b] with their proportionate percentages as components of the earth's crust:

Oxygen	50
Silicon	25
Aluminum	10
Calcium	4.5
Magnesium	3.5
Sodium	2

[a] The *crust* is the superficial portion of the earth. Prestwich *Geology*, p. 10.

Potassium	1.6
Carbon	2.4
Iron	
Sulphur	
Chlorine	
Other elements	1
	100

Chemical History of the Earth

In whatever manner our earth came into being, every known fact indicates that in the beginning it must have been intensely heated and in a gaseous condition. In obedience to the laws of matter such a mass would constantly lose heat, and with this loss of heat would come a gain in density, first at the surface only, but gradually progressing toward the center till at that point its constituent matter had reached at least a fluid condition. This may be the present condition of the earth's interior. As an eminent chemist has observed, here commences the chemistry of the earth, and the probable course of events can best be stated by quoting from the words of the late T. Sterry Hunt. As long as the earth's component matter remained in a gaseous condition and its temperature was sufficiently high to prevent the elements from combining, these elements remained separate, but as the temperature was reduced, chemical combinations of these elements became possible, and those would be first formed which were stable at the higher temperature. The oxides of silicon, aluminum, calcium, magnesium and iron were probably among the first substances formed. At some early stage of the earth's existence the bases alumina, lime, magnesia and oxide of iron were probably all combined with silica and that which represented the earth's crust was a fluid mass similar to a lava. The carbon, chlorine, sulphur and water vapor only existed in the primeval atmosphere, which must then have been too acid to permit the existence of any form of life, as it would probably have destroyed animal or vegetable

[a] Chemical and Geological Essays, pp. 37 et seq.

tissue. As the primeval temperature fell, the acid atmosphere would react on the lava-like crust and where the temperature fell below the boiling point of the acids which composed the atmosphere, the water of the globe would be highly charged with salts resulting from the chemical action. With the continued fall of temperature the chlorine and sulphur would be gradually removed from the atmosphere until the composition of the latter became similar to that of the present day, though containing more carbonic acid gas.

This chapter in the earth's history has been so well translated by the aid of chemical science that there is no reason to question its accuracy, but we do not know in detail the history of the massive rocks and gneisses which are now the oldest formations known. It also is probable that a long period of time elapsed between the formation of the primeval ocean and the dawn of life therein. Science has not yet taught us how to measure the length of this period or how to recognize the details of earth-building which occurred in it.

Present Condition of the Earth's Interior

It has been found by observations taken in deep mines and wells that in going toward the center of the earth, the temperature increases approximately at the ratio of 1 degree Fahrenheit to 51 feet of depth.* At this rate, a temperature would prevail at the depth of 50 miles at which all known substances would be fused. On this basis rests the theory of a molten interior, which is corroborated by various volcanic phenomena. All through the historic period and through long geologic ages before, volcanoes have poured out from subterranean sources vast quantities of molten rock. Physicists who have investigated this matter claim that if the interior of the earth were fluid, the crust would yield to the attraction of the moon and that the phenomena of tides would occur within the earth itself. It also appears that the great pressure on the internal mass must keep it in a condition of solidity. In this connection it is pointed out that volcanic phenomena occur along

* The extreme ratios are $1 \div 40$ and $1 \div 80$.

lines of mountain making and that probably the outflows of molten rock are due to local relief of pressure by some upward movement within the mountain masses.

Envelopes of the Earth

The earth, besides possessing a solid crust and an intensely heated interior, has two fluid envelopes.

The gaseous envelope or atmosphere, which consists of the air we breathe, surrounds the entire globe.

The liquid envelope, of which the various portions are known as oceans, seas, gulfs, bays, lakes, etc., envelops the globe only in part, the exposed portions of dry land being known as islands and continents.

These two envelopes, under the influence of physical forces, are very active agents of destruction, transportation and deposition in their action on the earth's crust.

The present relations of the envelopes to the continents, the forms of the latter, the causes of climate, the origin of the winds and ocean currents are usually discussed under the head of physical geography. As this subject is not at present illustrated in the State Museum, the student is referred to the many excellent text-books on this science.

COMPONENTS OF THE EARTH'S CRUST, MINERALS AND ROCKS

The earth's crust consists of aggregates of matter which occur in stratified and unstratified masses and are known as rocks. The chemical combinations which form these rocks either singly or in mixture are called minerals. The minerals, therefore, all possess a definite chemical composition which can be expressed by formulæ. Rocks vary in composition, as they consist of one or more minerals. The rocks which are mixtures of several minerals vary in composition as the proportions of their components vary; and it is possible for specimens taken from the same rock mass to differ in chemical composition.

Minerals

Minerals are classified by their chemical composition and by the geometric forms which they assume in crystallization, each mineral having a certain range of forms from which it cannot depart.[a]

These forms are grouped in six systems named as follows: Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic and Triclinic. These systems are characterized by and named in accordance with the number and relation of the axes about which the external geometric faces are developed. In physical relation with these axes are distinct optical properties which can be determined by cutting the minerals in very thin slices and examining these by means of optical instruments. While there are over 700 recognized mineral species, only a small number are important to the geologist as rock making minerals. Of these a few are sometimes found to be the single components of entire rock masses.

Quartz, the crystalline form of silica, is frequently found in large masses in mineral veins and, in its fragmental form, constitutes beds of gravel and sand when loose and, when solidified by cementation, forms conglomerates, sandstones and quartzites.

Calcite and **aragonite** are two crystalline forms of carbonate of lime, the former of which is the chief constituent of many great beds of limestone; the latter is usually deposited by water in forms called stalactites, calcareous tufa, travertine, etc.

Dolomite, the double carbonate of lime and magnesia wholly or in part forms extensive strata of magnesian limestone.

Kaolinite, the hydrous silicate of alumina, is also a very prominent mineral in rock masses. In its pure condition it forms beds of potter's clay, and mingled with various kinds of rock-dust it constitutes extensive strata of clay and shale.

Of the minerals which mingle in the formation of rocks, the most important are quartz, the feldspars and the magnesia-iron silicates.

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[a] For an elementary discussion of crystallography as well as of mineralogy the reader is referred to Dana's *Manual of Lithology and Mineralogy*.

The **feldspars** are silicates of alumina combined with potash, soda or lime. The more common species are: *orthoclase* and *microcline,* silicates of alumina and potash.

Albite, silicate of alumina and soda.

Anorthite, silicate of alumina and lime.

Oligoclase, andesite and *labradorite,* which contain both lime and soda, and are intermediate between albite and anorthite.

In crystallization orthoclase is monoclinic, the others named are triclinic.

The triclinic feldspars are usually called *plagioclase* in technical rock nomenclature, and are referred to collectively by this term.

The **magnesia-iron silicates** are classified in three principal groups, the amphiboles, pyroxenes and micas.

The *amphiboles* are monoclinic and comprise hornblende, actinolite and tremolite.

Hornblende is a silicate of alumina, iron, lime and magnesia; it is very tough and somewhat fibrous in fracture, its color varies from dark green to blackish green. This is a very important constituent of granites and other crystalline rocks.

Actinolite is a fibrous variety, generally light green in color and containing less alumina.

Tremolite is usually white and contains but little iron and no alumina. It occurs generally in crystals scattered through crystalline limestone.

Asbestus is a finely fibrous tremolite.

The *pyroxenes* have very nearly the same chemical composition as the amphiboles and are also monoclinic but crystallize with a different prismatic angle.

Augite, which corresponds closely to hornblende in composition and resembles it in many ways, is an important constituent of many eruptive rocks such as diabase, basalt, etc.

Pyroxene is lighter in color than augite and similar to actinolite in composition.

Diopside corresponds closely to tremolite in composition and like it, occurs in limestones.

Besides the above species which are monoclinic, there is an important group of orthorhombic pyroxenes.

These are hypersthene, bronzite and enstatite.

Of the *micas* there are many species. The most important rock-making mica is *biotite*, a silicate of alumina, potash, iron and magnesia. It is brownish black in color and is abundant in the granites and gneisses.

Muscovite, a silicate of alumina and potash, is less important as a rock mineral but is valuable commercially for its thin transparent plates used in stove doors, etc.

The hydro-micas, *margarodite* and *damourite*, are similar to the true micas in composition but contain water.

Olivine, or *chrysolite*, is a silicate of iron and magnesia which occurs usually in small crystals or grains in igneous rocks. It is pale green in color.

Olivine is of special importance because from it, by decomposition, is derived a large proportion of the serpentine rocks.

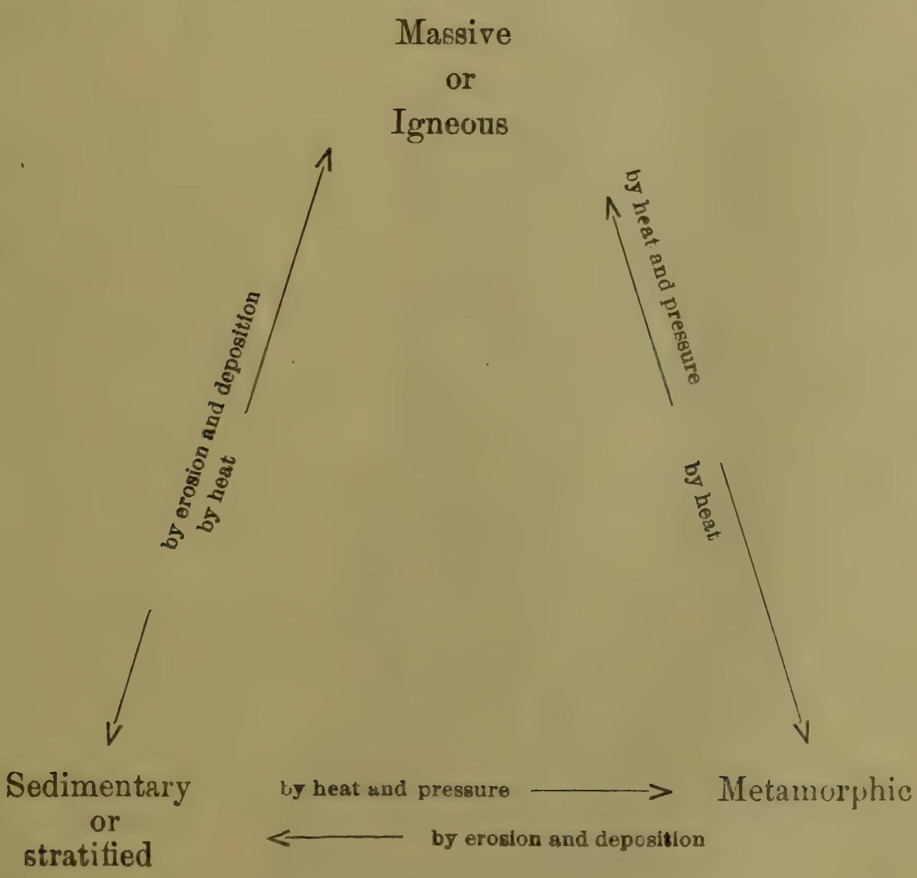
Besides these few minerals which are essential components of rocks and usually by their presence or absence determine the rock species, there are others which are only accessory and while of frequent occurrence do not so invariably affect the name of the rock in which they occur. Such are garnet, zircon and staurolite.

In addition to the rock-making minerals are those which occur in large masses in other rocks and have a commercial value. Such are corundum, or emery, the ores of iron, e. g. magnetite, hematite, spathic ore; coal, asphalt, halite or rock salt, gypsum, the ore of lead and silver, galenite; the ore of copper and gold, chalcopyrite and graphite or black lead.

Of rarer occurrence and great commercial value are the gems diamond, ruby, sapphire, emerald, etc. None of these are found in New York.

Rocks

These are the materials of the strata and other masses which form integral parts of the earth's crust. They may be classified as massive or igneous, sedimentary and metamorphic. The relations of these three natural groups may be shown by a triangular diagram, as follows:



This is meant to show that an igneous rock may, by erosion, be reduced to sediment and laid down in beds, or by heat and pressure may be metamorphosed from its original massive condition and become schistose. A sedimentary rock may also pass through the metamorphic condition, become fused and enter the igneous state. A metamorphic rock may arrive at the igneous condition by heat and pressure, or may become sedimentary through erosion and deposition.

Igneous rocks

The igneous rocks are very numerous, but may be classified in a few groups by mineral composition and texture. The texture indicates usually the conditions of their cooling. If the cooling occurred at a considerable depth, the process was gradual, crystals of the component minerals formed slowly and freely, and the resulting texture is coarse. If the cooling was in the open air, as in a lava bed, the process was more rapid; there was not sufficient time for crystals to form, and the resulting texture is fine or glassy.

The first class is called *plutonic*, the second *volcanic*. Plutonic rocks abound in the regions where old geologic formations are exposed, since there, either the intrusions did not reach the surface or the surface material which cooled as lava was removed by long erosion, and we see only those parts which were deeply covered while cooling. Examples of this are seen in the Palisades of the Hudson; the granite mountains, Anthony's Nose, Storm King, Breakneck and other peaks of the highlands, and in Mt. Marcy, Whiteface, etc., of the Adirondack chain. The volcanic rocks are chiefly exposed in regions of the newer formations because of the deep-seated plutonic masses have not yet been brought to view by erosion. The only good exposure of this character in New York is the mass of red porphyry or trachyte at Cannon's Pt., near Essex, on Lake Champlain.

This statement involves the theory that every volcanic mass has beneath it, or connected with it, a plutonic mass of the same general chemical composition.[a]

The names of a few important igneous rocks and their essential compositions are given below according to the classification of Rosenbusch.[b]

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a The accurate classification of rocks dates from about 1873, with the development of methods of study with the microscope. Most of the older books in English are much behind the present German standard of progress.

b Mikroskopische Physiographie der Mineralien und Gesteine.

PLATE I.—To face page 124.

H. Ries, photo.

GRANITE DYKE IN HUDSON RIVER SCHIST, SOUTH SIDE OF 192D ST., NEW YORK CITY.

PLATE II.—To face page 124.

H. Ries, photo.

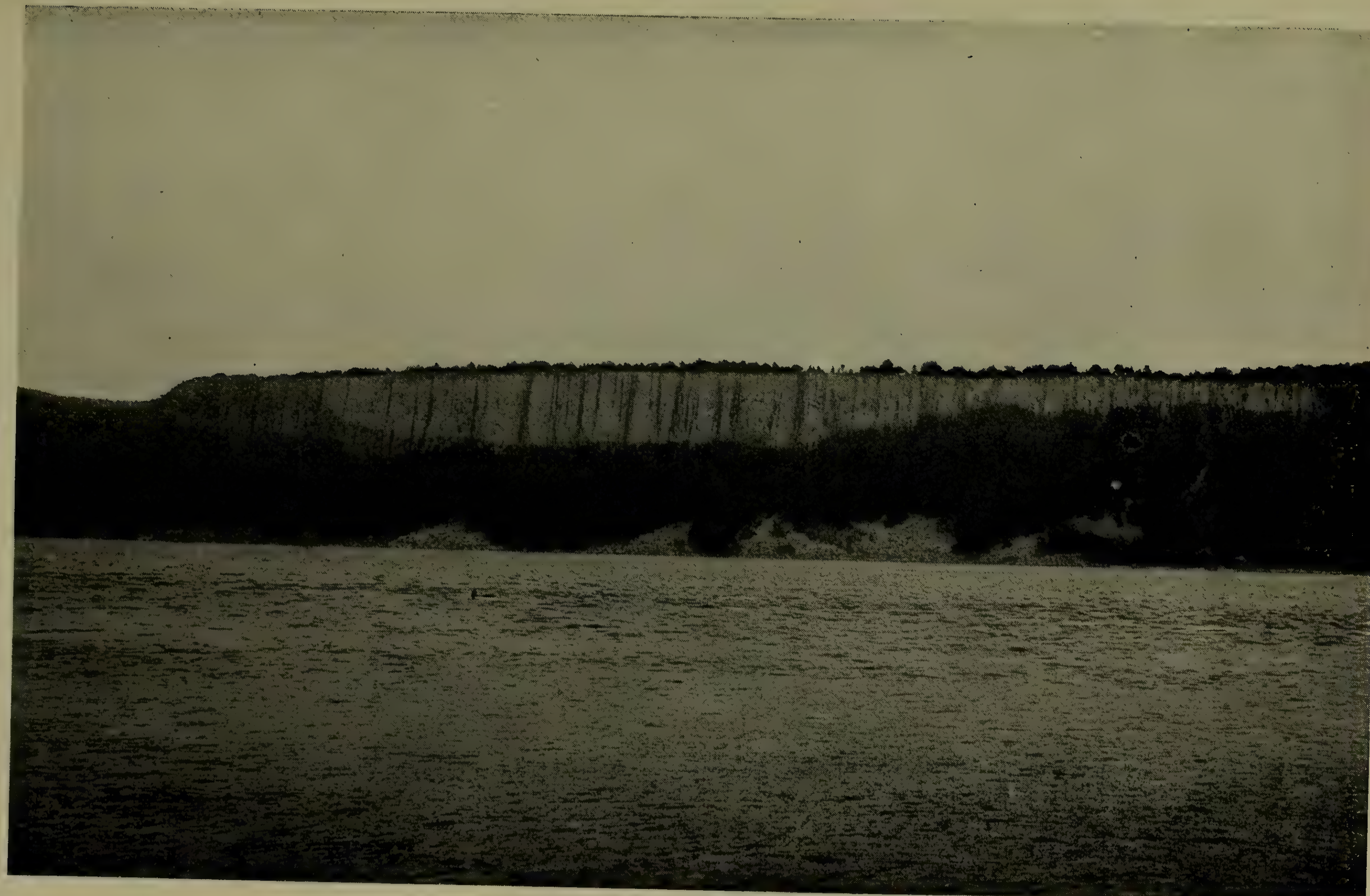
IGNEOUS GRANITE ON LOWER SILURIAN LIMESTONE, 192D ST., NEW YORK CITY.

PLATE III.—To face page 124.

H. Ries, photo.

EXPOSURE OF SERPENTINE ROCK, HOBOKEN, N. J. DERIVED FROM THE CHEMICAL ALTERATION OF AN IGNEOUS ROCK.

PLATE IV.—To face page 124.



H. Ries, photo.

Palisades of the Hudson River, Seen from Hastings, Westchester Co. Triassic Diabase Overlying Sandstone, Which is Concealed by the Talus.

Orthoclase and hornblende		Plagioclase and hornblende		Plagioclase and augite		Plagioclase and hypersthene
With quartz	Without quartz	With quartz	Without quartz	With olivine	Without olivine	
Granite	Syenite	Quartz diorite	*Plutonic* Diorite	Olivine diabase	Diabase	Norite
Quartz porphyry rhyolite	Trachyte	Quartz porphyrite	*Volcanic* Andesite porphyrite	Basalt	Augite andesite	Hypersthene andesite

Sedimentary rocks

These are, for the most part, deposited in water, and are of three classes, mechanical, chemical and organic.

The principal examples of these are:

Mechanical
1 Sand, gravel, sandstone and conglomerate. These are the debris of rocks containing quartz.
2 Clay and shale. These are formed of the debris of feldspar and the residuum from impure limestone.
3 Tuffs. Deposits of loose volcanic materials.

Chemical
4 Rock salt (chloride of sodium), deposited by evaporation from bodies of salt water.
5 Gypsum (sulphate of lime), deposited by evaporation from bodies of salt water. All sea water contains sulphate of lime.

Organic
6 Limestone, deposited in oceans from debris of marine animals, corals, mollusks, etc.
7 Coal, formed from accumulations of vegetation in marshes.

Metamorphic rocks

These have been subjected to heat and pressure usually in the presence of moisture, and have lost their original form and structure. They include the following:

Gneiss, which ordinarily has the same composition as granite,[a] with a foliated or schistose structure.

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a In modern usage the word *gneiss* designates only the schistose or foliated structure and any massive rock made schistose by metamorphism is called gneiss.

Schist, mica schist, hydromica schist, talcose schist, etc. Various members of the mica group play an important part in the schists.

Slate. This is mainly shale hardened by metamorphism and rendered fissile by pressure. The roofing slates are good examples.

Crystalline limestone. This is sedimentary limestone made crystalline by heat and pressure.

All kinds of igneous rocks may become schistose by metamorphism and then receive names indicating their composition and structure.

HISTORIC GEOLOGY

Historic geology treats of the succession of geologic deposits and is based on the study of sedimentary rocks.

It is estimated that the geologic series consists of about 100,000 feet or 20 miles thickness of sedimentary strata. These are beds of sediment chiefly formed by successive invasions of the sea and the transportation and deposition by it of debris detached from the rocks of the mainland by rain, frost, rivers and the ocean waves.

It has been estimated that about 99% of all rocks are sedimentary, and although some of these were formed in fresh water, probably the larger part of the sedimentary rocks were deposited in the ocean. It has consequently been said that 'the sea is the mother of continents.' On our Atlantic coast, as elsewhere, the ocean is both a destructive and a formative agent. As the soundings show, the loose materials washed from the land are spread out about 100 miles from the shore line in a broad, sloping plain of sand and mud. In such submarine deposits, when uncovered by the ocean's retreat, we find the remains of mollusks, fishes and other marine forms of life. Besides, land animals are often drowned and their bodies are carried out to sea and covered with sediment, leaves fall on the water and sink to the bottom. Therefore, in rocks formed in the sea we sometimes find remains of land animals and plants, besides the marine forms which we expect. The unceasing action of

rain and frost, rivers, waves and currents through all time has led to the deposition of a succession of strata which on the whole are unbroken in their sequence, though they have varied so much in the areas of their deposition that in no region do we find the series complete. There has been a break of continuity in those areas which for a time were elevated above the sea, but the continuity of the geologic series has always been maintained in one area or another. Contemporaneous strata are found only in those areas which are simultaneously depressed and which were submerged during the same time.

Contemporaneous strata may differ widely in composition owing to differences in material and the conditions of their deposition. Thus the Potsdam sandstone in northern New York is contemporaneous with a limestone in Saratoga and Dutchess counties.

As a result of the alternating invasions and retreats of the ocean over the land, we find in various geologic systems what is known as a trinity of formations,[a] viz. a base consisting of *sandstone* or *conglomerate*, a center consisting chiefly of *limestone* and a summit of *shale* or *mud stone*.

The cause of this alternation is not fully known. The sandstones and conglomerates are usually solidified beach and shoal water deposits. The shales are solidified sea bottom deposits consisting of the finer material carried from the shore by waves and currents and also of sediment carried into the sea by rivers.

The limestones were probably formed in many cases as at the present day, in warmer waters, which permitted the luxuriant growth of corals, mollusks and other marine invertebrates which have external skeletons composed of carbonate of lime. In New York there were coral reefs in the Trenton, Niagara and Corniferous periods. Whether corals in Palaeozoic time required the same warm temperature of water as at the present day, we do not know.

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a Geikie's *Text Book of Geology*, IIIrd Ed. p. 454.

DYNAMIC GEOLOGY

Under this head there is only enough space to enumerate the different agencies which are productive of geologic change or are associated with it. For a detailed discussion the student is referred to the text-books.

The dynamic agencies of geology may be roughly classified into two groups: *hypogene* or subterranean and *epigene* or superficial. Under the first head the principal agencies are volcanoes, earthquakes, secular changes of level and metamorphism. These, as their group name indicates, are chiefly controlled by forces that work beneath the surface of the earth; the second or epigene group comprises those which are chiefly manifest upon the earth's surface. First among these is the air. Air in motion or wind, is of marked importance as an agent of transportation as manifested in sand dunes, at places where deposits of fine sand occur, chiefly on the sea shore and in deserts.

A more active agent than air is water. By the action of its terrestrial forms, rain, snow and ice and by the cumulative forms of these, rivers and glaciers, the highlands are reduced and vast amounts of material are transported by the aid of gravity.

The oceanic waters are agents of destruction, transportation and formation. Waves beat upon the land and loosen fragments from the rocks upon which they beat. These fragments, carried out within reach of the oceanic currents, are borne along and drop to the bottom forming sand bars and other sub-aqueous deposits. Lastly, animal and plant life, both terrestrial and aquatic, are formidable agents of change, both destructive and constructive.

Resumé

Hypogene or subterranean agencies

Volcanoes
Earthquakes
Secular change of level
Metamorphism

Epigene or superficial agencies

Air

Water { terrestrial
oceanic

Erosion and sedimentation

Animal and plant life.

PALAEONTOLOGY

In studying an extensive series of geologic formations from bottom to top, we find that through geologic time there has been a progressive advance in the development of animal and plant life as well as a change of genera and species. Forms that are abundant at one horizon seem to have ultimately given up the battle for existence and disappeared, their place in nature being filled by others. So by careful comparison of the animal and vegetable remains found in the different systems and groups and in the minor sub-divisions of the groups, we come to regard the fossils as labels by which we may know the age of strata. While there are some persistent types which pass from one system to another without material change, we find that the life characteristics of each group are essentially distinct. It is therefore important for the field geologist who is studying the formations above the Archaean to be familiar with their fossils in order to determine the horizons accurately.

In the older formations, plants were few and elementary and, containing but little mineral matter, have not been well preserved so that we depend more on fossil animals than plants for the identification of the Palaeozoic strata. From the Mesozoic on, impressions of land plants are more abundant and become of much value in palaeontology.

As shown by the fossil remains discovered in rocks of different ages, the development of animal life has been a gradual one, but we are not yet acquainted with any formation which contains the earliest forms of life. We begin our study, as it were, at a somewhat late period of life development, the Cambrian, for the fossils of the pre-Cambrian rocks are not yet well known. Somewhere

and at sometime, an opportunity will be afforded for the study of pre-Cambrian life. West of the Rocky mountains, stratified deposits of great thickness are known beneath rocks of Cambrian age and these may, in time, when carefully searched, yield an abundant fauna.

Development of Life

ANIMALS

In classifying the animal kingdom, we find that by the presence or absence of an important feature it is possible to place most of the forms in two great sub-kingdoms: the invertebrates and the vertebrates; those without a backbone and those possessing one.

The animals without backbone are considered lower in the scale of development, as they have, in general, less intelligence and fewer resources. They are usually dependent for protection on an external skeleton or armor which encloses their soft bodies.

The vertebrate animals are, in general, characterized by relatively higher intelligence and have, at their command, more ways of protecting themselves and securing a living. The soft parts of their bodies are built around a bony skeleton and they depend for self protection more generally on their activity and intelligence than upon mere mechanical means of protection such as shells or armor.

Among the invertebrates the cuttlefishes were and are still the most highly developed type in regard to size and power though the crustaceans are considered to be more highly organized; among the vertebrates, man is supreme.

As we do not know the whole history of life development, we cannot show accurately in a diagram or scheme the relations of the different groups. The older arrangement which is still used in many text-books of geology is as follows:

Classification of Animal Life

Sub-kingdoms		Classes	Examples
Vertebrates		Mammals	Man, cow, horse, sheep, dog, whale, etc.
		Birds	Owl, turkey, hawk, sparrow, etc.
		Reptiles	Serpents, lizard, tortoise
		Amphibians	Frog, toad, salamander
		Fishes	
Invertebrates	Mollusks	Cephalopods	cuttlefish
		Pteropods	
		Gasteropods,	snail, etc.
		Lamellibranchs,	clam, oyster, etc.
		Brachiopods	
		Tunicates	
		Bryozoans	
	Articulates	Crustaceans,	trilobite, crab, lobster
		Insects	
		Worms	
	Radiates	Corals, starfish, etc.	
	Protozoa	Sponges, foraminifera, etc.	

This classification though time-honored and convenient in elementary palaeontology, has been superseded among zoologists by one slightly different, which indicates more truthfully the relations of the various groups or branches in point of development.

The following diagram by Packard[a] may be taken as representing the modern view.

Sub-kingdoms of animal life

VIII Vertebrata
Fishes to man

VII Arthropoda
Crustaceans and insects

VI Mollusca*
Snails, clams and oysters, cuttlefish

V Vermes
Worms

IV Echinodermata
Sea urchins, star fish

III Coelenterata
Corals, jelly fish, etc.

II Porifera
Sponges

I Protozoa
Foraminifera, polycystines, etc.

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[a] *First Lessons in Zoology*, p. 10

* The Brachiopods, Tunicates and Bryozoans are now separated from the Mollusca into the group of Molluscoida.

PLANTS

The following classification will give a general idea of the development of vegetable life.

- 4 Phanerogamia or Spermatophyta
  - Angiosperms
    - Dicotyledons or Exogens — Most of the forest trees and shrubs, oak, ash, etc.
    - Monocotyledons or Endogens — Palms; Lilies; Grasses, etc.
  - Gymnosperms — Conifers, pine, spruce, etc.; Cycads
- Cryptogamia
  - 3 Acrogens or Pteridophyta — Lycopods or Club mosses; Ferns; Equisetae or Horsetails
  - 2 Anogens or Bryophyta — Mosses; Liverworts
  - 1 Thallogens or Thallophyta
    - Fungi — Mushrooms, etc.
    - Lichens
    - Algae — Sea weeds; Diatoms

This classification is not now used in the more modern books on botany, but is followed in most of the text-books of geology.

PHYSIOGRAPHY AND STRUCTURE

In order to appreciate the position and attitude of the geologic formations in New York, it is necessary to form a mental picture of its physiography. For the purpose of reference the following terms may be adopted to describe the principal physiographic divisions of the state:

I The Adirondack upland, comprising the Adirondack mountain region and the adjacent territory.

II The southern upland; west of the Hudson river and south of the line of the Mohawk valley prolonged to Buffalo.

III The Highland-Taconic range; the mountains of granite crossing the Hudson river near West Point, and those of mica schist along the New England border.

IV The Central valley, consisting of the valley of the Mohawk and the low land extending from it to the Niagara river.

V The Hudson-Champlain valley, including the basin of Lake Champlain.

VI The Coastal plain, including Long Island and southern Staten Island.

As the geologic map shows, the principal Palaeozoic outcrops in New York have three principal positions and directions:

1) In zones encircling the Adirondack upland. These zones are much disturbed locally by faults, so that the outcrops are irregular. 2) In lines parallel with the Highland-Taconic range. This mountain axis has a northeast direction in the Highlands of the Hudson, changing gradually to north in the Champlain valley, where the Green mountain uplift is tangent to that of the Adirondacks. 3) In east and west lines across the southern upland from Albany county to the Niagara river and Lake Erie, locally intersected by river and lake valleys.

That portion of the state bordering on the Pennsylvania boundary is a high plateau, with summits about 2000 feet above tide. Its surface slopes gradually northward toward Lake Ontario and its component rock strata slope or dip southward.

From this it results, that, as we go southward from Lake Ontario, we ascend in vertical altitude and also in the geologic column. Our youngest Palaeozoic rocks, which are Lower Carboniferous, are near the Pennsylvania boundary.

These physiographic features are well shown on the accompanying relief map of New York.

For a detailed discussion of the geography of New York see Examination bulletin 11, University of the State of New York, by Wm. Morris Davis.

GENERAL CLASSIFICATION OF GEOLOGIC TIME AND STRATA

It must be realized by the student at the outset that all classification is to some extent arbitrary. There was throughout the earth as a whole a continuous process of erosion and sedimentation and a continuous chain of life. Locally, through changes of level, sedimentation was varied and life interrupted from time to time. For convenience in discussion, a scheme of arrangement has been adopted which is based on the more conspicuous of these breaks in life and sedimentation.

According to the classification most generally accepted, the principal divisions of the geologic time scale are called *aeons* or *times* and designated by the following names which are based on the principal features of life development:

Cenozoic, latest time, characterized by forms closely related to those of the present day.

Mesozoic, middle time of life development.

Palaeozoic, early time; ancient forms of life well developed.

Proterozoic or **Agnotozoic**, life not well known as yet.

Archaean time of the most ancient rocks with only suggestive traces of life.

The *aeons* are subdivided into *periods* as follows:

Æons	Periods	Prevailing types of animal life
Cenozoic	Quaternary or Pleistocene	Mammals
	Tertiary	
Mesozoic	Cretaceous	Reptiles
	Jurassic	
	Triassic	
Palaeozoic	Carboniferous	Fishes
	Devonian	
	Upper Silurian	Mollusks
	Lower Silurian or Ordovician	
	Cambrian	Crustaceans
Proterozoic or Agnotozoic	Keeweenawan	Not known in New York
	Huronian	
Archaean, not yet sub-divided	Laurentian	

The rock formations of the aeons are called *series* and of the periods, *systems*.

The systems may be described in general terms as those divisions of the series which are world-wide in their differentiation. The subdivisions of the systems which are called *groups* are chiefly local and variable. The groups are divided into *stages*.

Part 2.

GEOLOGIC FORMATIONS OF NEW YORK

New York is the mother state in geologic nomenclature, and the names chosen by its early corps of geologists have been adopted in a large degree throughout the whole of the United States. It has moreover, exposed within its borders, a more complete and extensive series of the formations below the Carboniferous and above the base of the Cambrian than any other state in the Union. It is therefore evident that a complete and representative collection of the New York rocks is of no small importance and the description of its formations is a matter of much interest.

Synopsis

System	Group	Stage
Carboniferous		Olean Conglomerate of Allegany and Cattaraugus counties. This is the Pottsville Conglomerate of Pennsylvania.
Devonian	Chemung–Catskill	
	Portage	Portage sandstone Naples beds Gardeau shale and sandstone Cashaqua shale
	Hamilton	Genesee slate Tully limestone Hamilton: Encrinal limestone; Ludlowville shale Marcellus shale
	Corniferous	Corniferous limestone Onondaga limestone Schoharie grit Cauda galli grit
	Oriskany	Sandstone

System	Group	Stage
Upper Silurian	Lower Helderberg	Upper Pentamerus limestone Delthyris shaly limestone Lower Pentamerus limestone
	Salina	Shale, limestone, salt and gypsum
	Niagara	Niagara shale and limestone Clinton sandstone, limestone and shale
	Medina	Medina sandstone Oneida conglomerate
Lower Silurian	Hudson river	Pulaski and Lorraine shales Frankfort slate Utica slate
	Trenton	Trenton, Black river, Birdseye, Chazy limestones
	Calciferous	
Cambrian	Potsdam	Sandstone and limestone
	Acadian	
	Georgian	Quartzite and slate
Archaean		gneisses and Granites

Archaean

This name was proposed by Prof. J. D. Dana to include those ancient crystalline rocks, which in nearly all countries are seen to underlie the oldest fossiliferous strata.

Although various subdivisions and classifications have been proposed at times, in the light of present knowledge their accuracy is uncertain and they will not be mentioned here.

The Laurentian rocks of Canada may be regarded as types of the Archaean.

In New York, as elsewhere, this system is represented by a series of crystalline rocks including gneiss, granite, diorite and norite. Crystalline limestone is often associated with them, but we do not know whether it should be regarded as truly Archaean. These rocks are exposed where uplifts from below in early time raised them up to form islands in the Palaeozoic seas, or in later time have caused them to break through the overlying strata. An instance of the latter occurs at Littlefalls, where the hard, red and gray granite has been forced up in a dome and appears

PLATE V.—To face page 138.

J. N. Nevius, Photo.

PRECAMBRIAN GNEISS. MOHAWK VALLEY, LITTLEFALLS, HERKIMER CO.

in the gorge of the Mohawk protruding through the Hudson river shale and Trenton limestone.

Beneath the metamorphic rocks of the Archaean and intersecting them, are found what are known as Plutonic[a] rocks, the peculiarity of which is, that they are not found in layers or strata, but in solid masses, and appear to have been forced up from below in a plastic condition. They form the central mass of the Adirondacks, and large areas of them are found in the Highlands and in many parts of New England. They were once generally called 'primary' or 'primitive', as it was believed that they were the original crust of the earth, first formed in the cooling of its melted mass, but it is now doubted whether, if such a crust exists, it can be identified, and many geologists think that most of the granites and other plutonic rocks are only re-melted and altered forms of older ones. That many such masses are so, is certain; and whether we can find any which are portions of an original crust of the globe, is at least very doubtful.

Containing no fossils, these rocks have their chief interest in their value for economic uses in building and other purposes, and in the cabinet specimens of the minerals which they so often contain.

The Archaean rocks cover two separate tracts of country in this state, one in its southeastern part known as the Highlands; the other lying in the central portion of the great Adirondack wilderness.

Various kinds of rocks are mingled over most of these areas, seeming often to change or gradually pass into each other. The metamorphic masses of gneiss, etc. are more fully exposed (as a general rule) around the edges of the tracts, where they pass under the lower strata of fossiliferous rocks; while the granite, hypersthene and other plutonic masses are more fully developed near the centers of these areas and among the highest of the mountains.

Throughout the Archaean districts there are many dykes, or veins of trap or other igneous rock penetrating masses of a different character. Not infrequently, a mountain or hill shows

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[a] Plutonic, from Pluto, king of the infernal regions in Pagan mythology.

such dykes cutting across or through it for a long distance, and to an unknown depth. These represent cracks or clefts by which the country has been riven and which have been filled by the rise of melted matter from below. They are all sizes, from half an inch to 100 feet or more in thickness.

Plutonic dykes are not confined to Archaean regions. Dykes of granite are seen in many places on New York island, penetrating in every direction the Lower Silurian mica-schist which forms the masses of its territory.

These are examples of a phenomenon frequently observed, viz.: a plutonic rock penetrating strata of Paleozoic or later age. They are similar in their origin to the out-flows of lava from volcanoes.

A prominent example of a late plutonic intrusion is seen in the 'palisades' of the Hudson, which is described under the Triassic rocks.

The plutonic and metamorphic rocks generally decompose slowly and produce a poor or barren soil. The districts formed of these rocks are the least fertile in our state, except where overlying deposits of glacial drift and alluvium furnish a soil which is adapted to tillage and the support of vegetation.

Typical Localities of the Archaean

The most southern locality of Archaean rock in New York state is on New York island, between 7th and 8th avenues south of 155th street. This is a good exposure and is typical of the Archaean gneiss of southeastern New York. This gneiss is well shown throughout Westchester county along the shore of the Hudson, though at a few points Lower Silurian limestone and mica-schist occur. A little north of Peekskill may be seen the granite mountains of the Highlands, which traverse Orange and Putnam counties. These are chiefly massive, though on their flanks are some gneissoid rocks and in many of the valleys are Palaeozoic limestones and schists. Other localities are seen in Dover mountain and in Stissing mountain in Dutchess county. North of this southeastern area, the Archaean rocks are chiefly confined to the region known as the Adirondack wilderness.

PLATE VI.—To face page 140.

J. F. Kemp, photo.

FOLDS IN FORDHAM GNEISS, NORTH SIDE OF 138TH ST., EAST OF 7TH AVE., NEW YORK CITY. PRECAMBRIAN.

PLATE VII.—To face page 140.

H. Ries, photo.

HIGHLANDS OF THE HUDSON. PRECAMBRIAN. VIEW FROM PEEKSKILL.

PLATE VIII.—To face page 140.

Anthony's Nose. Manitou Mountain.

H. Ries, photo.

HIGHLANDS OF THE HUDSON. PRECAMBRIAN. ANTHONY'S NOSE AND MANITOU MOUNTAIN.

PLATE IX.—To face page 140.

Crow Nest. Storm King.

H. Ries, photo.

HIGHLANDS OF THE HUDSON. PRECAMBRIAN. CROW NEST AND STORM KING.

PLATE X.—To face page 140.

F. J. H. Merrill, photo.

VIEW OF THE HIGHLANDS OF THE HUDSON AND SUGAR LOAF MOUNTAIN, FROM FT. MONTGOMERY, ORANGE CO. PRECAMBRIAN.

PLATE XI.—To face page 140.

H. Ries, photo.

BREAKNECK MOUNTAIN. SEEN FROM THE SHORE OPPOSITE COLD SPRING, PUTNAM CO. PRECAMBRIAN GRANITE.

PLATE XII.—To face page 140.

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ying
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Precambrian granite.

H. Ries, photo.

FISHKILL MOUNTAIN, SEEN FROM CORNWALL, ORANGE CO. PRECAMBRIAN AND LOWER SILURIAN.

PLATE XIII.—To face page 140.

S. R. Stoddard, photo.

GORGE OF THE HUDSON RIVER, LUZERNE, WARREN CO., AND HADLEY, SARATOGA CO. PRECAMBRIAN GNEISS.

PLATE XIV.—To face page 140.

PRECAMBRIAN ROCKS, ADIRONDACK MOUNTAINS. AVALANCHE LAKE, ESSEX CO.

PLATE XV.—To face page 140.

S. R. Stoddard, photo.

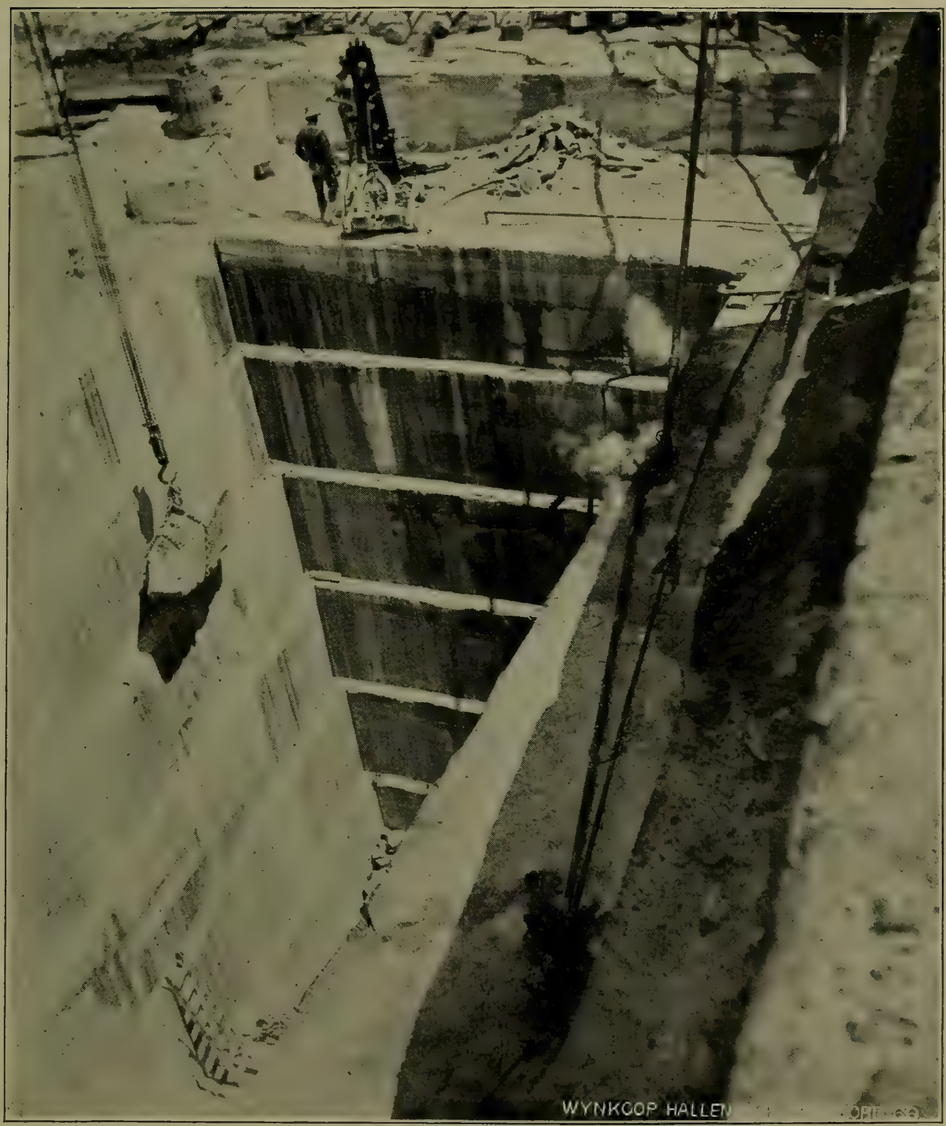
PRECAMBRIAN ROCKS, NORTH END OF WILLSBORO TUNNEL, SHORE OF LAKE CHAMPLAIN, ESSEX CO.

PLATE XVI.—To face page 140.

J. N. Nevius, photo.

Precambrian Marble, E. E. Stevens' Quarry, 3 Miles South of Canton, St. Lawrence Co.

PLATE XVII.—To face page 140.



J. N. Nevius, photo.

EMPIRE MARBLE CO.'S QUARRY NEAR GOUVERNEUR, ST. LAWRENCE CO.
PRECAMBRIAN.

The principal group of mountains, which includes Mt Marcy, is of massive rocks known as norite and anorthosite. The prevailing rocks of the wilderness are, however, gneisses of different kinds. In these are many local intrusions of granite and other eruptives. Trap, serpentine and many other rocks of igneous origin are found in all parts of the district. The great route of travel through Lakes George and Champlain is bordered by mountains and cliffs, in which these rocks are seen in great variety.

In the Mohawk valley are small exposures of pre-Cambrian, at Littlefalls and near Spraker's. These are important localities and show the relations of the over-lying Palaeozoic rocks.

Proterozoic or Agnotozoic

Rocks of this age are not definitely known in New York. They are well represented in the Lake Superior region by those formations known as Huronian and the copper bearing deposits of the Keeweenaw peninsula. West of the Rocky mountains, they are developed extensively. All rocks between the Archaean and the Cambrian are included.

Palaeozoic

Upon the plutonic and metamorphic rocks of the Archaean in New York rest directly the Palaeozoic strata which are all fossil-bearing rocks. The Palaeozoic series includes all strata from the base of the Cambrian to the summit of the Carboniferous.

These stratified fossil-bearing rocks form the greater part of the state of New York.

At the beginning of the Palaeozoic, all life was marine, probably because the land surfaces were at first too small to materially influence the evolution of living forms. In the Cambrian, crustaceans prevailed, in the Lower Silurian the Cephalopods or cuttle fishes, in the Devonian the soft boned fishes were the dominant type, while in the Carboniferous, fishes and amphibians divided the honors of the sea and the land.

In like manner plant life, beginning with marine forms of low type, gradually developed to the large tree ferns, sigillaria, lycopods and equisetae of the coal measures.

CAMBRIAN[a]

Subdivisions or periods

Potsdam	Sandstone around the Adirondacks Limestone in Dutchess, Washington and Saratoga counties
Acadian	Limestone in Dutchess county
Georgian	Roofing slates of Washington county Quartzite in Dutchess county

The first and lowest Palaeozoic system known in New York is the Cambrian, so called from *Cambria*, the latin name of Wales, where rocks of this age abound and were first studied by the British geologist, Adam Sedgwick. Our knowledge of the Cambrian of New York is largely due to the labors of C. D. Walcott, William B. Dwight, and S. W. Ford.

The base of the Cambrian system in New York and New England rests directly upon the Archaean rocks and its limit can be recognized by this fact, as well as by its containing the earliest known fauna. But the termination of the uppermost division is not so apparent, as it grades, both in sediment and fauna, into formations of the Lower Silurian system, thus showing that there was no great physical change to influence the transition. North of the Adirondacks the delimitation is more clearly defined.

The strata of the Cambrian system are classified as follows:

Upper Cambrian, or Potsdam.

The type rock is the sandstone of the northern and eastern borders of the Adirondack mountains, and correlated with it are certain limestones on the south side of the Adirondacks, near Whitehall and Saratoga Springs, and in Dutchess county near Poughkeepsie. The characteristic fossils are the Dikelocephalus trilobites.

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[a] The descriptions of the Georgian and Acadian groups are chiefly from the work of C. D. Walcott, Bulletin No. 81, U. S. Geological Survey.

Middle Cambrian, or Acadian.

The type rocks are the shales and slates of New Brunswick, Newfoundland and Braintree, Mass., and correlated with them are some limestones in Dutchess county. The characteristic fossils are the Paradoxides trilobites.

Lower Cambrian, or Georgian.

The type rocks are slates, limestones and the 'red sandrock' of western Vermont; and correlated with them the shales and interbedded limestones and roofing slates of Washington and Rensselaer counties. The characteristic fossils are the Olenellus trilobites.

Georgian

The lowest rock is a bedded quartzite, resting upon the Archaean. This is seen on the flank of Stissing mountain, and between Fishkill and Poughquag, in Dutchess county. From here its outcrops extend northeasterly through Massachusetts and Vermont, where it attains a great thickness.

At Stissing mountain it passes above into a limestone containing Lower Cambrian fossils. Above this lies a considerable thickness of arenaceous limestone, frequently passing into calcareous shale, and containing Middle Cambrian fossils.

Near Poughkeepsie an extensive limestone formation contains Upper Cambrian fossils.

Northward, in Washington county, the quartzite is represented by a great thickness of shales, slates, sandstones and limestones, well shown along a line between Greenwich and Salem, and the superjacent limestones of Dutchess county are entirely replaced in both Rensselaer and Washington counties by slates, shales and sandstones. Mingled fossils of Lower and Middle Cambrian are found at Berlin, Rensselaer county. These formations continue northeastward into Canada.

The great belt of *roofing slate* in western Vermont and Washington county, belongs to this (Georgian) group. The greatest development of this formation is at Georgia, Vt., from which place it extends southward into Washington county, where it

is quarried at Middle Granville and vicinity, and broadening out southward, extends nearly across the southern part of Rensselaer county.

Acadian

The Middle Cambrian, or Acadian, group is not so well developed in New York.

Marble and limestone of this age are found resting conformably upon the Lower Cambrian rocks about Stissing mountain, shown in the cut for the N. Y. & Mass. R. R. near Stissing, and extending into Massachusetts, where the development is greater. A portion of the Stockbridge limestone may belong to this group, though most of it is Lower Silurian.

Potsdam

The Upper Cambrian, or Potsdam, group is exposed over a larger area in New York than the two lower divisions and is typically represented by the Potsdam sandstone, which is seen in many places to rest directly upon the Archaean. It is a hard silicious sandstone and an excellent building material, often thinly bedded and usually reddish-brown in color, though sometimes gray or buff. On many of its layers, are waved surfaces, precisely resembling the ripple-marks seen on sandy bottoms over which waters are agitated by waves or currents. They were formed in the same way, by movements of the waters in which were deposited the sands which were finally hardened into the Potsdam sandstone. Similar markings are frequent on almost all sandstones. The edge of this formation can be traced nearly all around the region of the Adirondacks, except between Canajoharie and Carthage, and is especially well seen near Keeseville in Clinton county, where the deep chasm of the Ausable river is cut through it, showing 333 ft. of horizontal strata, at Chateaugay chasm, where the section exposes a thickness of 250 ft., and at Potsdam, St Lawrence county, from which place it received its name, and where, in the valley of the Raquette river a thickness of 70 ft. is shown.

PLATE XVIII.—To face page 144.

J. N. Nevius, photo.

POTSDAM SANDSTONE, QUARRY OF MERRITT & TAPPAN, 3 MILES SOUTH OF POTSDAM, ST. LAWRENCE CO.

PLATE XIX.—To face page 144.

J. N. Nevius, photo.

Potsdam Sandstone Resting Unconformably upon Precambrian Gneiss. Dodge Farm, Macomb, St. Lawrence Co.

PLATE XX.—To face page 144.

N. H. Darton, photo.

POTSDAM SANDSTONE RESTING UNCONFORMABLY ON PRECAMBRIAN GNEISS. HUDSON RIVER NEAR JESSUPS LANDING, SARATOGA CO.

PLATE XXI.—To face page 144.

S. R. Stoddard, photo.

HELL GATE, AUSABLE CHASM, CLINTON CO. POTSDAM SANDSTONE.

PLATE XXII.—To face page 144.

S. R. Stoddard, photo.

POTSDAM SANDSTONE, GRAND FLUME, AUSABLE CHASM, CLINTON CO.

PLATE XXIII.—To face page 144.

N. H. Darton, photo.

GLACIATED SURFACE OF POTSDAM CONGLOMERATE, MOSHERVILLE, SARATOGA CO.

PLATE XXIV.—To face page 144.

N. H. Darton, photo.

POTSDAM CONGLOMERATE ON PRECAMBIAN CRYSTALLINE ROCKS, MOSHERVILLE, SARATOGA CO.

In the northern part of Lewis county the Potsdam sandstone, in a few small exposures, rests unconformably upon the Archaean terrane, and passes above into the Calciferous formation. It extends almost continuously through Jefferson, St Lawrence, Franklin and Clinton counties, and appears southward in the Champlain valley in irregular outcrops.

The Potsdam, though not seen distinctly in the Mohawk valley (where its place between the Archaean and the Calciferous sand rock appears to be vacant) is a thick mass in Pennsylvania, and is known northeastward and northwestward over a great area.

The base of the Potsdam at a few places in New York is a coarse conglomerate which gradually passes upward into the typical sandstone.

Near Whitehall, Saratoga and Poughkeepsie, the Potsdam horizon is represented by a limestone and at the two former localities it passes upward into the Calciferous formation without marked change except in fauna.

The characteristics of the Cambrian strata lead to the conclusion that the sediments were accumulated in shallow seas near the shore of a slowly sinking land. As the water slowly encroached upon the land in late Middle or early Upper Cambrian time, deeper water gradually covered the earlier longshore deposits, and finer sediments were deposited upon them. Toward the close of Cambrian time (Potsdam) only the higher parts of the continent were above the sea. At this time the Potsdam sandstone was deposited along the shores, while in the deeper water the conditions were becoming favorable for the formation of the great beds of Silurian limestone. The conglomerate at the base of the Potsdam, grading upwards into the finer sediments of the sandstone, indicates the deepening of the water along the shore line of the Cambrian ocean.

At their greatest development in Washington county, the Cambrian formations have a total thickness of 10,000 or 12,000 feet.

Life of the Cambrian

So far as we know, the life of the Cambrian was wholly marine. No vertebrates are known to have existed. The Brachiopods were small. The Lamellibranchs, so far as known, were also very small. There were representatives of the groups of Pteropods and Gastropods. Cephalopods appeared in the Upper Cambrian. There were also sponges, and corals. The trilobites, however, were the only forms which had attained large size or high development. Besides these were some other articulates, the Ostracoids and Phyllopods, and probably some worms. The plants were sea weeds.

LOWER SILURIAN OR ORDOVICIAN

This system is a subdivision of the original Silurian system which received its name from that of the *Silures*, an ancient race inhabiting the eastern part of Wales, where Sir Roderick Murchison studied these rocks in detail. The second name was derived by the British geologist Lapworth from that of the *Ordovices*, also an ancient British tribe.

In New York this system is well developed and includes the following subdivisions:

System	Group	Stage
Lower Silurian	Hudson river	Hudson river shale and sandstone
		Utica slate
	Trenton	Trenton
		Black river
		Birdseye
		Chazy
	Calciferous	

Calciferous Group

Overlying the Upper Cambrian or Potsdam sandstone at many points is another, which contains a considerable proportion of lime mingled with it, and from this fact has received the name of the Calciferous sandrock.

It may be described as a silicious or gritty limestone, generally of a brownish color, lying in straight, thin layers, and attaining

N. H. Darton, photo.

CALCIFEROUS SANDROCK RESTING ON PRECAMBRIAN CRYSTALLINE SCHISTS, WEST SHORE R. R. CUTTING, 1 MILE WEST OF DOWNING STATION, MONTGOMERY CO.

PLATE XXVI.—To face page 146.

N. H. Darton, photo.

CALCIFEROUS SANDROCK, EAST CANADA CREEK, HERKIMER CO., 1 MILE ABOVE ITS MOUTH.

PLATE XXVII.—To face page 146.

N. H. Darton, photo.

CALCIFEROUS SANDROCK, EAST CANADA CREEK, HERKIMER CO., TWO MILES ABOVE ITS MOUTH.

PLATE XXVIII.—To face page 146.

H. Ries, photo.

VIEW OF INWOOD, MANHATTAN ISLAND. PLAIN OF CALCIFEROUS-TRENTON LIMESTONE. HILLS RIGHT AND LEFT OF HUDSON RIVER SCHIST. PALISADES (TRIASSIC) IN THE BACKGROUND.

PLATE XXIX.—To face page 146.

H. Ries, photo.

MARBLE QUARRY, SING SING, WESTCHESTER CO. METAMORPHOSED CALCIFEROUS-TRENTON LIMESTONE.

a total thickness of 200 or 300 feet. It is well seen at the 'Noses' about Fonda on the Mohawk, and also at Littlefalls; in each of which places it has been raised to the surface by an uplift which has brought it from its original position below the Hudson river shales which are common in this region. It may also be seen near Middleville on West Canada creek (where it contains in its cavities many beautiful quartz crystals), and in many places in the vicinity of Lake Champlain and the St Lawrence river, in which latter region it has some layers so purely calcareous as to be profitably burnt for lime.

Outside of the Mohawk valley the Calciferous is a true limestone and in parts of Columbia, Dutchess, Putnam, Westchester, Orange and Rockland counties cannot be separated from the Trenton.

Trenton Group

Above the rocks of the Calciferous group between the Mohawk valley and the Canadian border succeeds a thick series of bedded limestones known as the Trenton group. This group has four principal divisions, Chazy, Birdseye, Black river and Trenton. These four divisions are nowhere all found together.

Chazy Limestone

Overlying the Calciferous sandrock in northern New York is a dark, irregular, thick-bedded limestone, which derives its name from the village in Clinton county where it was first studied.

Its thickness is about 730 feet on Lake Champlain: but, in striking contrast with the wide extent of many other rocks, it is known only in the Champlain valley, and does not appear to extend in any considerable thickness into those parts of the state west or south of the Adirondack region. It is not seen as a distinct or separate mass in the Mohawk valley, though the rocks above and below it are of well known occurrence outside of New York.

Birdseye Limestone

The rock which succeeds the Chazy limestone is one well known in the Mohawk valley, as well known along the Black river and

Lake Champlain: it is a fine grained, gray, brittle, limestone, 30 feet in its greatest thickness: and the most conspicuous of its fossils is one of which the nature is somewhat obscure, but which was regarded as the stem of some marine plant.

Standing in an upright position, perpendicular to the strata the ends of the stems are seen on the surface of the layers, to which they give a peculiar dotted appearance, from which the rock has derived its name, and by which, as well as by its characteristic color and fracture, it is easily recognized. It is a valuable rock for economical uses, as it is a good building stone, and dresses well under the chisel; it is quarried to a considerable extent at various points in the Mohawk valley.

Black River Limestone

To the Birdseye limestone succeeds a thin mass, amounting in all to only 10 or 12 feet, but classed as a distinct rock from having a somewhat peculiar mineral character and containing a peculiar set of fossils. It is a dark, thick-bedded, compact, hard limestone, fine grained and taking a high polish, and is worked as a black marble at Glens Falls on the Hudson river, and at Isle La Motte on Lake Champlain. It is also well seen at Watertown, Jefferson county, in the banks of the Black river from which locality it has been named.

In the last place it is lumpy and irregular in texture, and not fit for good masonry or marble; and is known among quarrymen as 'the seven foot tier.' In the Mohawk valley it seems to have been deposited in only a few places, the Birdseye being generally covered directly by the Trenton.

Trenton Limestone

Above the Black river limestone (or where this is absent, lying upon the Birdseye), is one of the most interesting repositories of organic remains in the state; a thick group of limestone strata, usually black and fine grained with seams of slate toward the lower part, but gray and crystalline near the top.

PLATE XXX.—To face page 148.

N. H. Darton, photo.

GLENS FALLS ON THE HUDSON RIVER, SARATOGA AND WARREN COUNTIES. TRENTON LIMESTONE.

PLATE XXXI.—To face page 148.

N. H. Darton, photo.

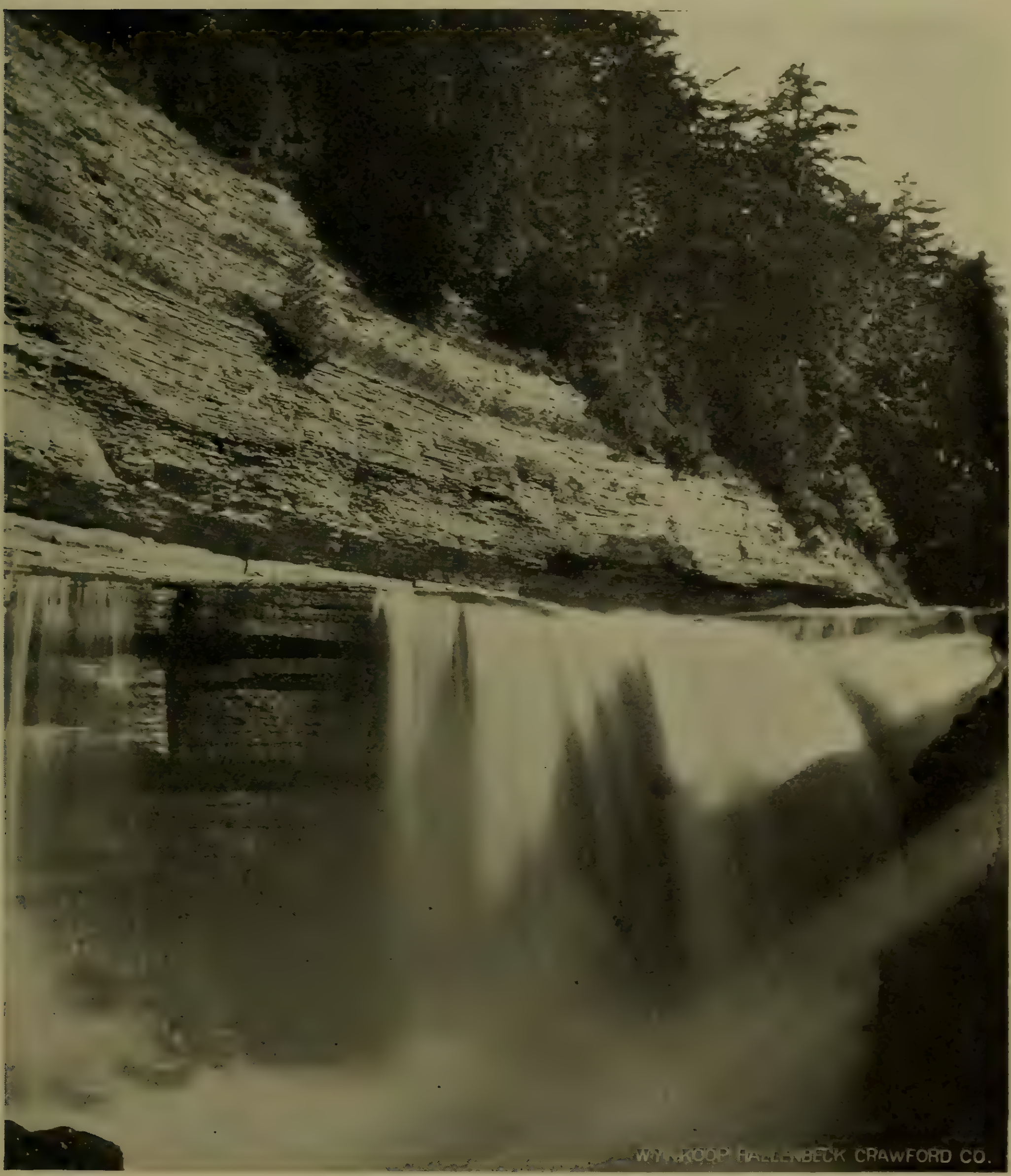
UPPER GORGE, TRENTON FALLS, ONEIDA CO. TRENTON LIMESTONE.

PLATE XXXII.—To face page 148.

N. H. Darton, photo.

PRINCIPAL CASCADE, TRENTON FALLS, ONEIDA CO. TRENTON LIMESTONE.

PLATE XXXIII.—To face page 148.



N. H. Darton, photo.

TRENTON LIMESTONE, SPENCER FALL, TRENTON FALLS, ONEIDA CO.

PLATE XXXIV.—To face page 148.

N. H. Darton. photo.

UTICA SHALE, TRENTON LIMESTONE AND CALCIFEROUS SANDROCK, CANAJOHARIE, MONTGOMERY CO.

It attains an entire thickness of more than 300 feet, and, succeeding the lower rocks as already described, its edges surround the great Adirondack region in an almost unbroken circuit. Seen at Glens Falls on the Hudson, along the Mohawk at Fort Plain and elsewhere, on the west shore of Lake Champlain, and at many points on the shores of the St Lawrence, it also outcrops along the valley of the Black river and is crossed by West Canada creek at Trenton Falls, from which place it takes its name.

In many places it furnishes building stone of excellent quality.

Hudson River Group

This formation, which is next in upward succession, is an enormous deposit of sandstone, slate and shale. The lower part of the Hudson river group is a fissile black slate about 75 feet thick, known as the Utica slate.

The higher strata, to which the name of the Hudson river group is more usually restricted, are gray slaty masses, with coarse sandstones, especially toward the top, and in some places near the summit of the group, a coarse sparry limestone.

In the eastern part of the state these rocks are 3,500 feet thick, as shown by a boring near Altamont in Albany county. They are well seen in the north of Oswego county, near Pulaski, the south of Lewis county and the middle of Oneida county; also through the Mohawk valley, and from Glens Falls southward along the Hudson river, from which these strata take their name. West of Schenectady they are generally level and undisturbed; but near the Hudson river these strata are upheaved, broken, folded and faulted in every conceivable manner, as may well be seen in many places near Cohoes and Albany and along the Hudson river railroad. In much of this disturbed region the rock has been changed in texture by the forces to which it has been subjected and fossils are very rare.

That part of New York lying east of the Hudson, and along the western border of New England is formed of an enormous mass of upheaved and contorted strata of slate, schist sandstone and limestone, which were at one time supposed to be older than

the Potsdam sandstone, and were called Taconic. This range of rocks contains very few fossils or none in most localities, and geologists have been obliged to study it without the aid which fossils would have given in explaining the relation and true position of its confused and contorted strata. The general conclusion has been that this series of strata is not a separate and distinct one, but merely the eastward extension of the rocks older than the Medina and Clinton groups, changed in character or 'metamorphosed' by the effect of heat and pressure. The work of Walcott and others has proved that most of the schistose rocks are of Hudson river age, though a portion of them contain Lower and Middle Cambrian fossils and are therefore distinct.

In Westchester and New York counties, rocks of Hudson river age cover large areas. They are, however, metamorphosed into mica schist and contain no fossils.

Life of the Lower Silurian

The animal life of this system was also marine and chiefly represented by sponges, corals, brachiopods, mollusks and crustaceans. Cephalopods were the dominant forms and were of great size. Fishes have recently been announced by C. D. Walcott. No land animals are known to have existed except some insects reported from Europe. Vegetable life was represented by sea weeds, though a land plant has been found in Great Britain.

UPPER SILURIAN SYSTEM

The Upper Silurian system, which is the upper division of the original Silurian system, consists in New York state of the following divisions:

System	Group	
Upper Silurian	Lower Helderberg	
	Onondaga Salt Group	Waterlime Salina
	Niagara	
	Clinton	
	Medina	
	Oneida	

PLATE XXXV.—To face page 150.

N. H. Darton, photo.

GORGE IN THE UTICA SHALE SOUTH OF CANAJOHARIE, MONTGOMERY CO.

PLATE XXXVI.—To face page 150.

H. Ries, photo.

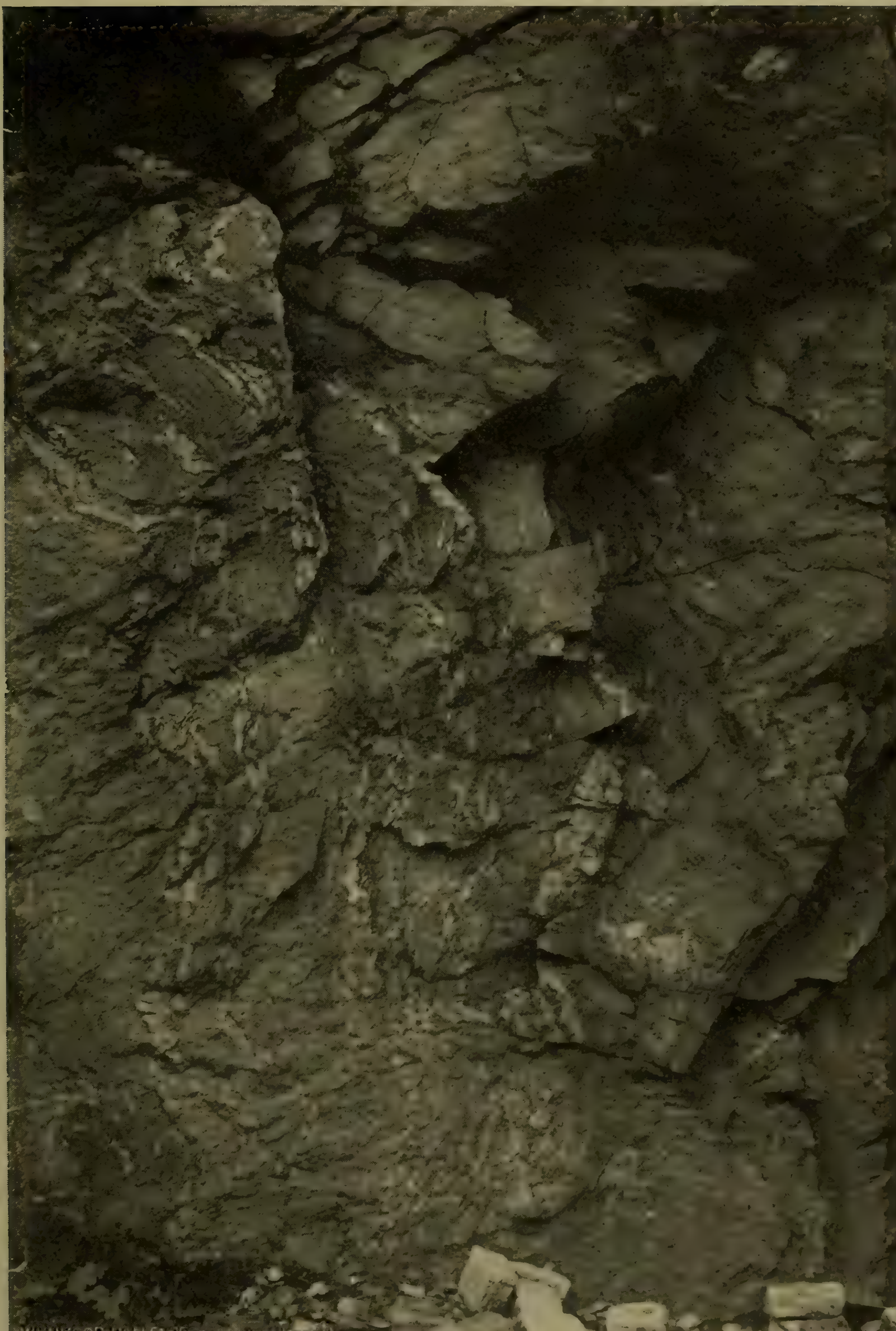
FOLD IN SANDSTONES OF THE HUDSON RIVER GROUP, CATSKILL CREEK, GREENE CO.

PLATE XXXVII.—To face page 150

J. N. Nevius, photo.

HUDSON RIVER SHALE IN RAILROAD CUTTING. KENWOOD, ALBANY CO. DIP VERTICAL.

PLATE XXXVIII.—To face page 150.



J. F. Kemp, photo.

Crumpled Hudson River Schist, with Pegmatite Veins, Opposite 130th St., on West Side of St. Nicholas Ave., New York City.

PLATE XXXIX.—To face page 150.

H. Ries, photo.

METAMORPHOSED HUDSON RIVER MICA SCHIST OVERLYING SEMICRYSTALLINE CALCIFEROUS-TRENTON LIMESTONE. VERPLANCK'S POINT, WESTCHESTER CO.

Generally speaking, the lowest of these groups lies conformably upon the strata of the Hudson river group,—the uppermost of the Lower Silurian,—though in eastern Albany county the Hudson river shales are much disturbed.

In regard to this relation it has been said by Dana[a]: 'Cases of intervening erosion may be found, for every period loses by erosion a large part of its deposition in the supply of material for the beds of the following period.'

Oneida Conglomerate

The Hudson river group is covered in many places by a bed of conglomerate consisting chiefly of coarse sand and rounded pebbles of quartz, cemented together into a firm mass. Being well developed in Oneida county south of Utica, it has received its name from that of the county.

It is the base of the Lower Silurian system. In central New York it is but a few feet in thickness, and indeed seems to be entirely wanting in many places; but in the lower Hudson valley it swells to a thickness of several hundred feet and southwest of Rondout forms the Shawangunk mountain from which it receives the name of Shawangunk grit. From this place its upheaved edges may be traced in the range of hills southeast of the Delaware and Hudson canal and parallel to it, and the same rock forms most of the mountain range of the Kittatinny or Blue Ridge, along which the Delaware flows from Port Jervis, where it leaves New York, to the famous Delaware Water Gap where it cuts through the barrier. From this point, its edge ranges southward to Virginia. No fossils have yet been discovered in it: indeed the rolled and worn condition of its materials would indicate that it was formed under agitated waters, which did not allow the growth or preservation of organic forms.

The well known summer resort of Lake Mohonk is on the Shawangunk grit.

The 'Rensselaer plateau,' in Rensselaer county, is an extensive outcrop of greenish conglomerate, resting conformably

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a Man. Geol. pp. xxx

upon the Hudson river schists. This is probably equivalent to the Oneida conglomerate, or possibly the base of the Medina group.

The source from which such enormous quantities of rolled pebbles of quartz could have been derived and the mode by which they could have been spread so widely over a sea bottom is a very obscure question in geology. Several other such formations of conglomerate are known, two of which occur at the lower and middle parts of the Carboniferous system.

Medina Sandstone

The next succeeding group is that named from a village in Orleans county where it is well exposed.

It is a huge mass of sandy and shaly rock, of very variable hardness from soft marl to hard sandstone, and varying in color from deep red to olive and light gray. It is not known in the far west, seeming to thin out and disappear before reaching Wisconsin, but is well seen on the Niagara river, where it forms most of the precipice near Lewiston. At this point the lower part is a soft red shale, with harder and lighter colored layers above, to one heavy bed of which the cables of the Lewiston suspension bridge are fastened. This sandstone may also be seen in the lower part of the river cliffs, extending as far as the upper Suspension Bridge. The same rock is quarried near the lower part of Lockport for building and flagstone, and it forms the lower falls of the Genesee at Rochester, at the top of which the hard uppermost layer, called the ‘ Gray band,’ is very conspicuous from its light color. Further east, the same rock forms the falls of the Oswego river at Fulton; but in the Mohawk valley it thins out, and disappears. In southeastern New York, however, near Rondout, it re-appears and is very thick at the Delaware water gap in New Jersey and Pennsylvania, reaching, in the latter state, the thickness of 1,000 feet; and it may be recognized as far south as Alabama.

PLATE XL.—To face page 152.

N. H. Darton, photo.

EASTERN FACE OF SHAWANGUNK MOUNTAIN, 2 MILES SOUTH OF LAKE MOHONK, ULSTER CO. ONEIDA CONGLOMERATE RESTING ON HUDSON RIVER SHALE.

PLATE XLI.—To face page 152.

N. H. Darton, photo.

CLIFFS OF SHAWANGUNK GRIT ON THE WEST SHORE OF LAKE MOHONK, ULSTER CO.

PLATE XLII.—To face page 152.

N. H. Darton, photo.

AWOSTING FALLS OVER SHAWANGUNK GRIT, PETERKILL, NEAR LAKE MINNEWASKA, ULSTER CO. ONEIDA CONGLOMERATE.

PLATE XLIII.—To face page 152.

Medina shales and sandstone.

I. P. Bishop, photo

Niagara Gorge near Lewiston. Medina Group.

PLATE XLIV.—To face page 152.

Clinton limestone.

Clinton shale.

Medina grey sandstone.

Medina red shales and sandstones.

I. P. Bishop, photo.

NIAGARA RIVER GORGE, SOUTH OF LEWISTON, NIAGARA CO.

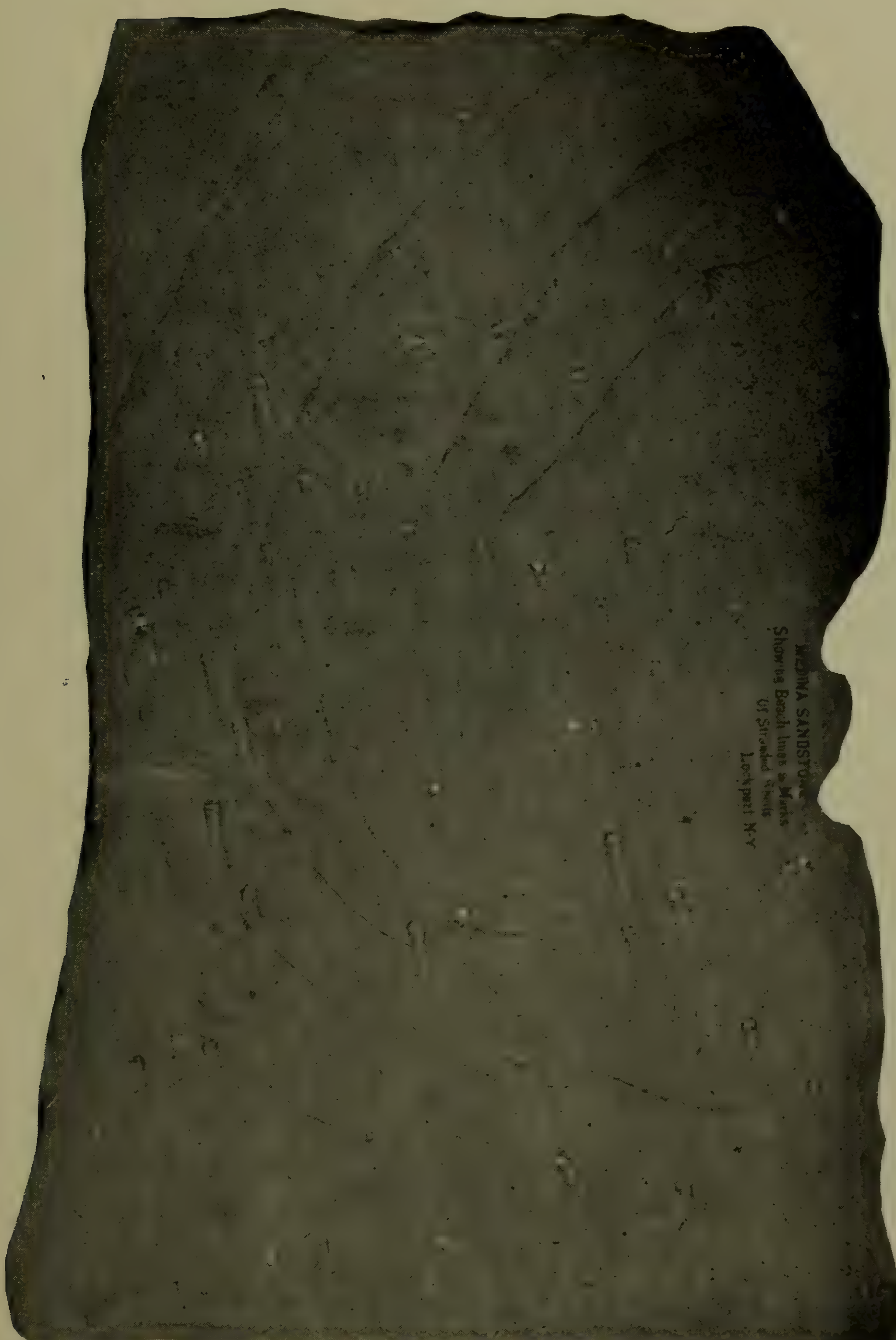
PLATE XLV.—To face page 152.

J. N. Nevius, photo.

BEACH MARKINGS ON MEDINA SANDSTONE.

SEAWEED, ARTHROPHYCUS HARLANI, ON MEDINA SANDSTONE.

PLATE XLVI.—To face page 152.



J. N. Nevius, photo.

BEACH MARKINGS ON MEDINA SANDSTONE, LOCKPORT, NIAGARA CO.
ORIGINAL SLAB 53 INCHES BY 32 INCHES.

PLATE XLVII.—To face page 152.

I. P. Bishop, photo.

Falls Over Medina Grey Sandstone, Near Lockport, Niagara Co.

PLATE XLVIII.—To face page 152.

I. P. Bishop, photo.

MEDINA GREY SANDSTONE, NEAR LOCKPORT, NIAGARA CO. QUARRY OF R. KEENEY.

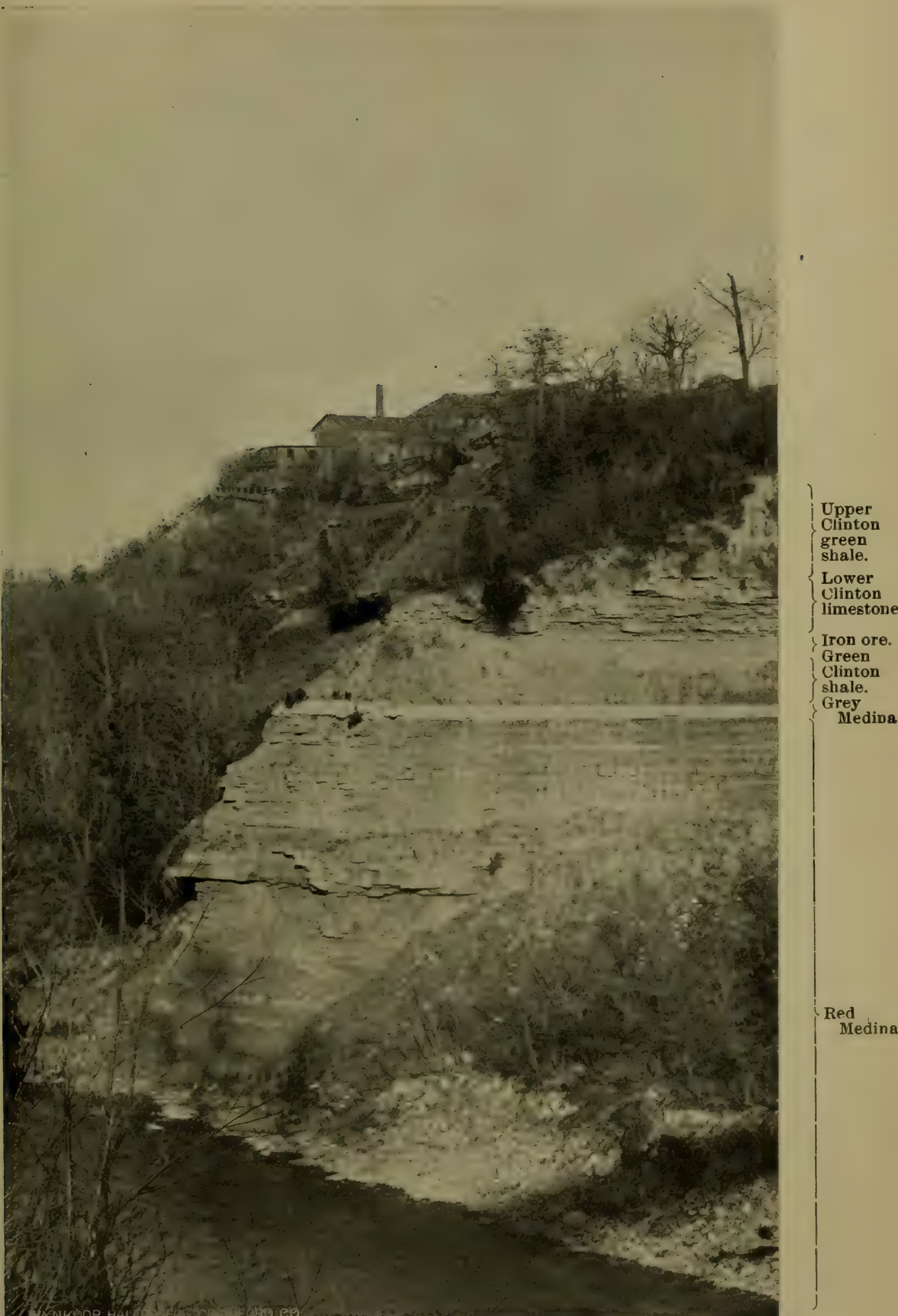
PLATE XLIX.—To face page 152.

Webster & Albee, photo.

Lower Falls of the Genesee River, Over the Grey Medina Sandstone. Monroe Co. Medina and Clinton Groups.

Webster & Albee, photo.

GORGE OF THE GENESEE RIVER, MONROE CO., BELOW THE LOWER FALLS. MEDINA, CLINTON AND NIAGARA GROUPS



Webster & Albee, photo.

GORGE OF THE GENESEE RIVER, MONROE CO., BELOW THE LOWER FALLS. MEDINA AND CLINTON GROUPS.

Clinton Group

Above the Medina sandstone lies a series of sandstones, limestones and shales, which receives its name from one of the localities where it is well seen, the vicinity of Clinton, Oneida county. This group of strata is hardly distinguishable east of Fulton county, appearing to thin out in the eastern part of the state, where it is all sandstone and greenish shale. In the western part of the state, however, it contains two distinct layers of limestone and two of greenish shale, which can be well examined above the lower falls of the Genesee river near Rochester. Two thin strata of iron ore are found in this group, and are extensively mined in the vicinity of Clinton; the ore is of a peculiar granular appearance like an aggregate of small shot, and contains many fossils of small size.

On the Niagara river, the upper limestone of this group is about 20 feet thick, and a very solid, massive rock. At the falls, this layer is near the level of the water below the cataract.

This group of rocks extends westward through Canada, but does not appear beyond Wisconsin as a distinct mass. It re-appears in Pennsylvania in enormously increased thickness, amounting to nearly 2,000 feet, and extends southward along the Appalachian chain even to eastern Tennessee. It seems everywhere to contain beds of iron ore of the same character as those in New York.

Niagara Group

This group consists in the region from Wayne county westward of two distinct members, a shale and limestone, which, are recognized as the products of one period, during which, there was an important change in the materials deposited and a lesser one in the animal life. The shale is a very uniform deposit throughout the whole extent of the fourth district; while the limestone, from a thin, dark colored, concretionary mass at the east becomes an extensive and conspicuous rock, constantly increasing in thickness in a westerly direction, even far beyond the limits of the state.

The cataract of Niagara is produced by the passage of the river over this limestone and shale; and from being a well known and extremely interesting locality, as well as exhibiting the greatest natural development of these rocks within the limits of the state, this name has been adopted for its designation.

Standing on the upper suspension bridge at Niagara Falls, one sees in the precipice, above the Clinton limestone, a sloping bank of soft gray shale about 80 feet thick, above which succeeds a thick series of layers of limestone forming the brink of the rocky wall: these are the Niagara shale and the Niagara limestone. The great cataract pours over their edges; and its vertical descent is owing to the fact that the soft shale below wears away more rapidly than the hard limestone which forms the top of the fall, thus maintaining a recess behind the descending sheet of water. These rocks are perfectly exhibited in the gorge of the Niagara river, especially along the Niagara Falls and Lewiston railroad.

The limestone at Niagara is about 160 feet thick (of which only the lower part is seen at the falls); at Rochester it is about 70 feet thick. The shale decomposes rapidly where exposed to the air, until it resembles a deposit of gray clay. It contains thin layers of limestone in many places, the surfaces of which are often covered with beautiful small corals of several species, and the shale itself contains them in great numbers. The 'deep cut' of the canal above Lockport is through the Niagara limestone, some layers of which there form a massive and beautiful building stone. The same limestone and shale form the upper falls of the Genesee at Rochester.

Salina Group, or Onondaga Salt Group

The next series of strata in upward succession is a group of shales and thin limestones, the whole of which in central and western New York attains a thickness of nearly 1,000 feet. Its lower part in central New York is composed for several hundred feet of a soft red shale or hardened clay, especially conspicuous along the Erie canal in Madison county. Its upper

PLATE LII.—To face page 154.

Niagara shale.

Clinton limestone.

I. P. Bishop, photo.

NIAGARA RIVER GORGE, BELOW DEVIL'S HOLE, NIAGARA CO. NEW YORK CENTRAL RAILROAD CUT.

PLATE LIII.—To face page 154.

Niagara shale.

Clinton limestone.

Clinton shale.

Medina grey sandstone.

I. P. Bishop, photo.

Niagara River Gorge, South of Lewiston, Niagara Co. New York Central R. R. Cut.

PLATE LIV.—To face page 154.

I. P. Bishop, photo.

WALL OF THE NIAGARA RIVER GORGE, AMERICAN SIDE. VIEW FROM FOSTER'S FLATS, 1½ MILES NORTH OF SUSPENSION BRIDGE.

PLATE LV.—To face page 154.

Niagara limestone.

Niagara shale.

Clinton limestone.

Clinton shale.

Upper grey Medina.

Medina red shales and sand-stones.

I. P. Bishop, photo.

NIAGARA GORGE BELOW THE SUSPENSION BRIDGE, NIAGARA CO. VIEW FROM THE CANADIAN SIDE.

PLATE LVI.—To face page 154.

I. P. Bishop, photo.

NIAGARA RIVER GORGE, FROM THE SUSPENSION BRIDGE, LOOKING NORTH. MEDINA, CLINTON AND NIAGARA GROUPS.

PLATE LVII.—To face page 154.

Niagara limestone.
Niagara shale.
Clinton limestone.
Clinton shale.
Medina grey sandstone, upper
Medina red shale.
Medina grey sandstone, lower.

I. P. Bishop, photo.

Outlet of the Whirlpool, Niagara River, Niagara Co. View Northward from the Canadian Shore.

PLATE LVIII.—To face page 154.

Lime-
stone.

Shale.

Webster & Albee, photo.

UPPER FALLS OF THE GENESEE RIVER, ROCHESTER, MONROE CO. NIAGARA GROUP.

PLATE LIX.—To face page 154.

Niagara limestone.

Niagara shale.

Webster & Albee, photo.

GORGE OF THE GENESEE RIVER. BELOW THE UPPER FALLS, ROCHESTER, MONROE CO. NIAGARA GROUP.

PLATE LX.—To face page 154.

I. P. Bishop, photo.

NIAGARA RIVER, NIAGARA CO. VIEW FROM BLUFF NEAR LEWISTON, LOOKING NORTH.

PLATE LXI.—To face page 154.

Salina shales.

Niagara limestone.

Clinton shales.

N. H. Darton, photo.

UPPER SILURIAN ROCKS IN ROAD CUT NEAR HOWE'S CAVE, SCHOHARIE CO.

PLATE LXII.—To face page 154.

N. H. Darton, photo.

Clinton and Salina Groups in West Bank of Rondout Creek, High Falls, Ulster Co., N. Y.

PLATE LXIII.—To face page 154.

N. H. Darton, photo.

ARCH IN SALINA AND CLINTON BEDS AT HIGH FALLS, ULSTER CO.

portion is generally a dark gray slaty rock, with layers of impure limestone, well seen along the Auburn and Syracuse railroad. The important salt springs of Syracuse being derived from these rocks, they received originally the name of Onondaga salt group.

In the days of the original Natural History Survey, the salt was not found in solid masses, though the gray part of the rock in some places showed impressions of the peculiar 'hopper shaped' crystals of halite or rock salt, proving that it once existed there in small quantities. It is now known to be diffused in beds and lenses through large extents of these strata, through which in places the surface water percolates and bears the salt in solution to the deep basin at Salina. This was found, by boring, to be several hundred feet in depth, filled with gravel and sand, in which the salt water seemed to lie as in a reservoir, and from which it is raised by the pumps for the supply of the evaporating works. The Onondaga lake, which is a comparatively shallow body of fresh water, lies over this deep mass of gravel, but has a water tight bottom of marl which keeps its fresh waters separate from the salt waters below.

During the past 18 years a large industry has been developed from the boring of salt wells in New York state at points distant from Syracuse, at Warsaw and in the Genesee valley. These wells show that rock salt in beds and lenticular masses varying in thickness from a few inches to 150 feet is abundantly intercalated between the layers of shale and limestone of the Salina group. This salt being easily soluble in water does not appear at the surface of the ground nor within reach of surface waters.

The upper drab or gray shales of this group contain great quantities of gypsum, which is quarried extensively from Madison county westward. The rock over the masses of gypsum often seems arched, as if this mineral, in forming, through some chemical change, had exerted an upward pressure, lifting the overlying masses.

The whole group is remarkably destitute of organic remains; not a single fossil having been found in the lower part or red shale, and but a small number in the upper portion at a few localities.

The Onondaga-salt group is hardly seen in New York east of Herkimer county. The succeeding formation, however, which is grouped with the Salina is fairly persistent.

Waterlime

Overlying the salt-bearing rocks and forming with them the Onondaga group is the Waterlime, a succession of dark-colored, fine-grained and straight-bedded layers of limestone, attaining in Madison county a thickness of over 100 feet. It lies immediately over the gray and drab limestones of the upper part of the salt group, and is not divided from them by any very distinct or sudden change in the appearance of the strata. The name is given from the waterlime or hydraulic cement which is extensively manufactured from two of the layers toward their upper part: these are generally of a drab color, and separated from each other by a thin mass of blue limestone. They are quarried, burnt and ground on a very large scale near Manlius in Onondaga county, and the hydraulic cement of Rosendale and Rondout is made from the same beds. That manufactured at Williamsville, Erie county, and at Buffalo, is from the upper limestones of the Salina group below; and in Niagara and Orleans counties, a similar cement is made from some layers of the Niagara group.

HELDERBERG ROCKS

Above the formations already described succeeds a thick series of strata, chiefly limestone, separated by sandstone and grit rocks, first described under the general name of the Helderberg rocks, as they formed the great escarpment of the Helderberg mountains in Albany county. From this place their edges may be followed southward in the hills lying west of the Hudson river, past the base of the Catskill mountains, and through Ulster county as far as Kingston and Rondout; whence their outcrops bend southwestward and extend along the hills west of the valley of the Delaware and Hudson canal, passing out of the state near the northwest corner of New Jersey. They run still farther southwestward, are seen above the Delaware Water Gap, and their

Cornif-
erous
limestone.

Onondaga
limestone.

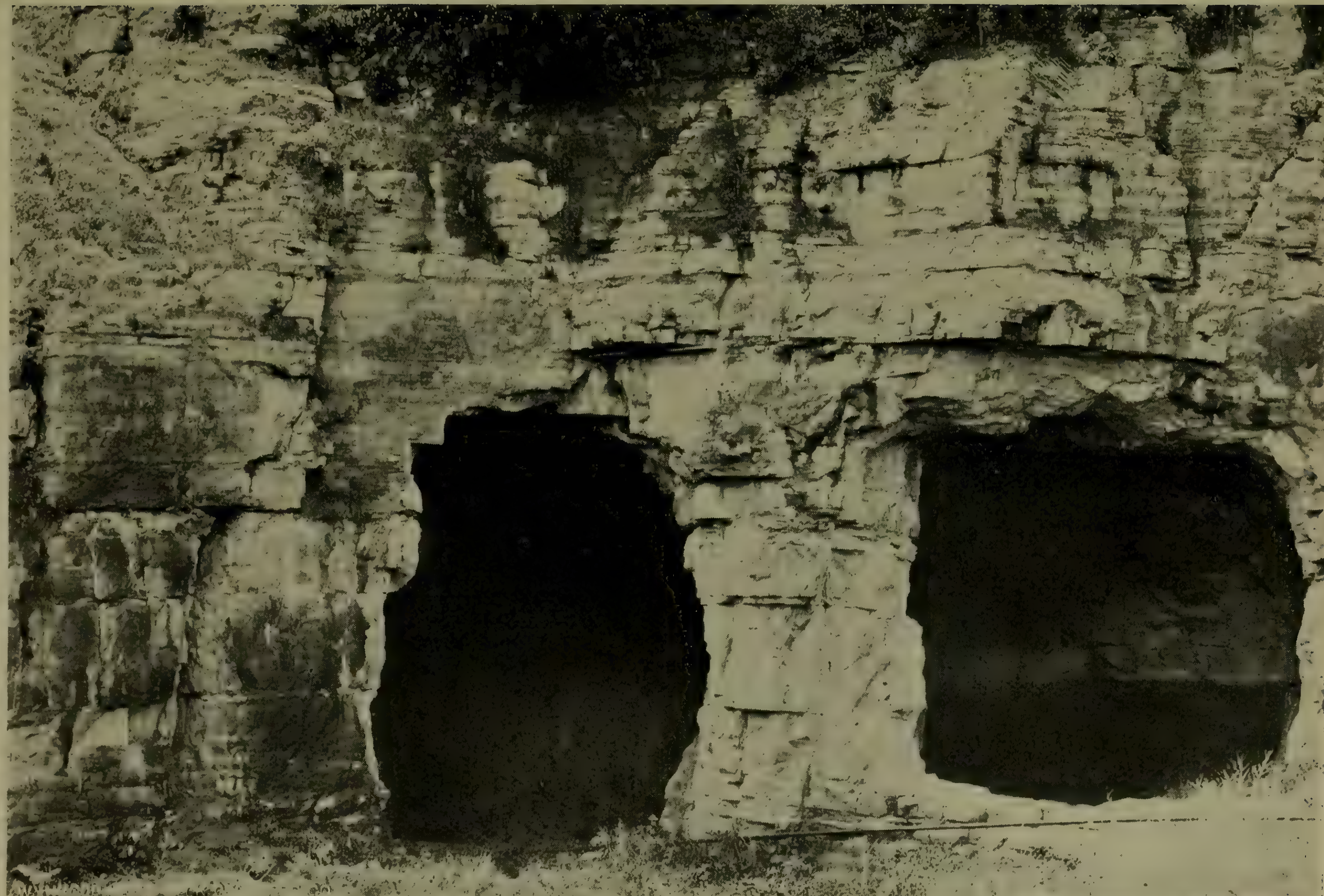
"Bull
head"
limestone.

Cement
rock.

I. P. Bishop, photo.

MINE OR QUARRY OF THE CUMMINGS CEMENT CO., AKRON, ERIE CO.

N. B.—The term "bull-head" is used by the quarrymen to denote the impure limestone which overlies the cement rock and is unfit for use.



H. Ries, photo.

OLD MINE OF THE NEWARK CEMENT CO., RONDOUT, ULSTER CO. WATERLIME GROUP.

PLATE LXVI.—To face page 156.

N. H. Darton, photo.

HIGH FALLS OF RONDOUT CREEK OVER CEMENT BEDS OF THE WATERLIME GROUP, ULSTER CO.

lower strata are traceable in the Appalachians as far as Tennessee, though their upper limestones do not extend beyond the Susquehanna. In following them westward from Albany county, we find the lower limestones and sandstones thin out rapidly, not extending beyond the Niagara in any considerable thickness, while the upper limestones are found spreading into the far west.

This series of rocks which may be considered collectively in its effect on topography, belongs partly to the Upper Silurian system and partly to the Devonian and may be divided into two parts; the Lower Helderberg limestones which are of Upper Silurian age, and the Oriskany sandstone and Upper Helderberg limestones which are included in the Devonian.

Lower Helderberg Group

The subdivisions of this group are as follows:

	Thickness
Scutella limestone Upper Pentamerus	15 ft. in Albany county
Delthyris, or Catskill shaly limestone	100 ft.
Lower Pentamerus limestone	65 ft. in Albany county
Tentaculite limestone	30 ft. "

The Scutella limestone, named from a fossil crinoid which it contains, is the uppermost member of the group where it occurs, but it has not been found associated with the Upper Pentamerus.

The Lower Pentamerus limestone is coarse-grained, thick-bedded and often a concretionary limestone; while the Catskill limestone is in thin layers, with much shaly or slaty matter interstratified with it.

The Lower Helderberg group has its greatest development in Albany and Schoharie counties; the subdivisions above given may be differentiated in Greene, Albany and Schoharie counties, but west of the last county they are not distinct and the group itself is indistinguishable from the Salina formation, at the surface, west of Seneca lake. In the Livonia salt shaft, however, about 35 feet of limestone was found containing Tentaculite fos-

sils. It may, with the waterlime, be traced through Pennsylvania and Virginia, but is very thin and not found everywhere, having been deposited locally in areas of no great extent.

Life of the Upper Silurian

There is no radical difference between the general character of the fossil remains of this system, and those of the Lower Silurian, but of several thousand species found in the Upper Silurian, only a few occur also in the Lower Silurian, and the animal forms are nearly all marine. Sea weeds were very abundant and a few land plants, similar to equisetae, occur.

DEVONIAN SYSTEM

This system takes its name from Devonshire in England where its rocks were studied by Sir Roderick Murchison.

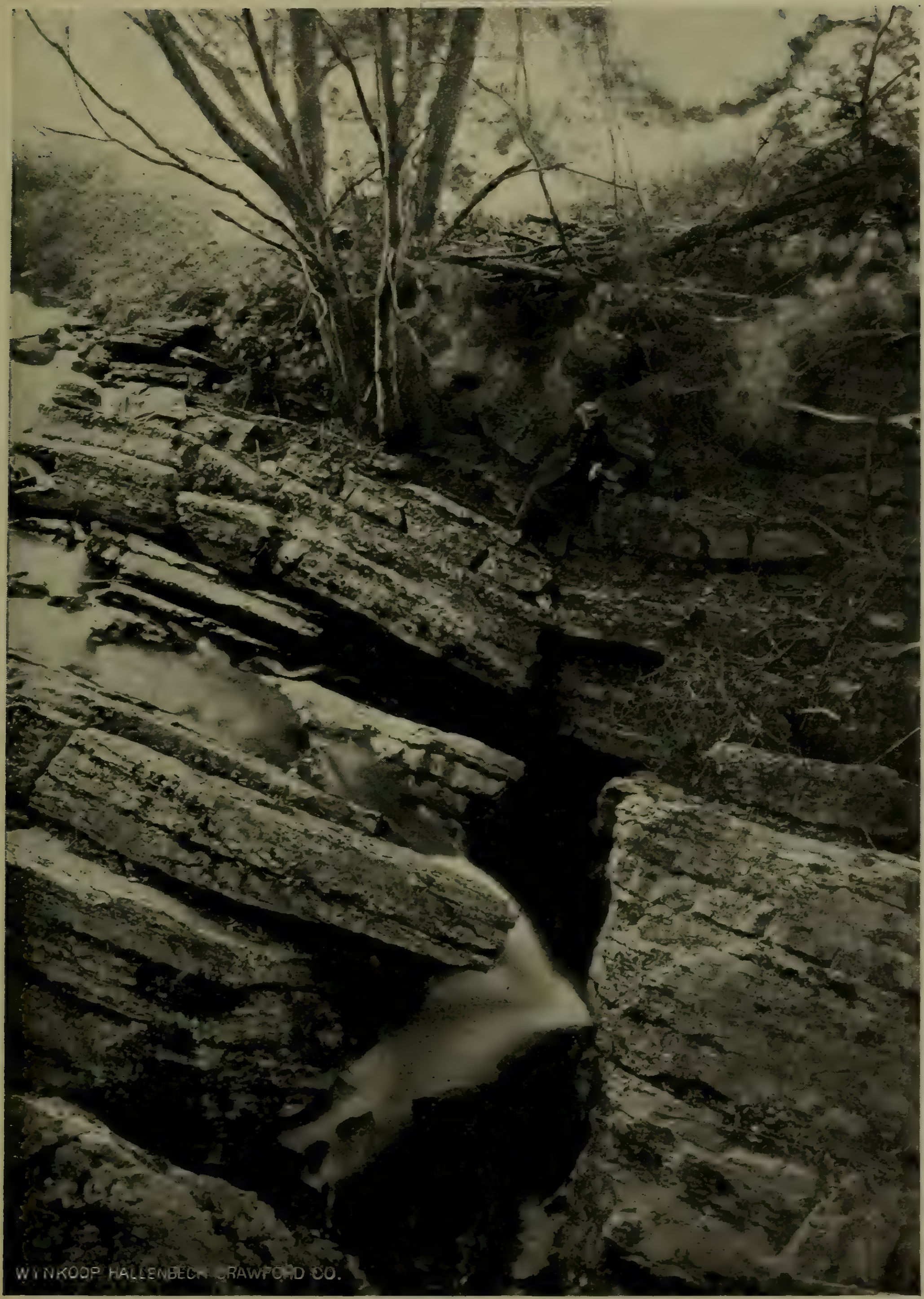
The Devonian was the age of fishes, since fishes were the prevailing type. America has probably the most complete series known of the Devonian rocks but they have a comparatively limited extent. The Devonian rocks contain much carbon in the form of bituminous shales and it has been suggested that there may be more carbon in the Devonian than the Carboniferous. These rocks are well developed in New York but the vertebrate life of the system is better shown in other states.

System	Group	Stage
Devonian	Chemung	
	Portage	Gardeau shales
		Cashaqua "
	Hamilton	Genesee "
		Tully limestone
		Moscow shale
		Encrinal limestone
		Ludlowville shale
		Marcellus "
	Corniferous	Corniferous limestone
		Onondaga "
		Schoharie grit
	Oriskany	Cauda Galli grit
		Oriskany sandstone

PLATE LXVII.—To face page 158.

HELDERBERG ESCARPMENT, WEST MOUNTAIN, SCHOHARIE, FROM A PHOTOGRAPH BY N. H. DARTON.

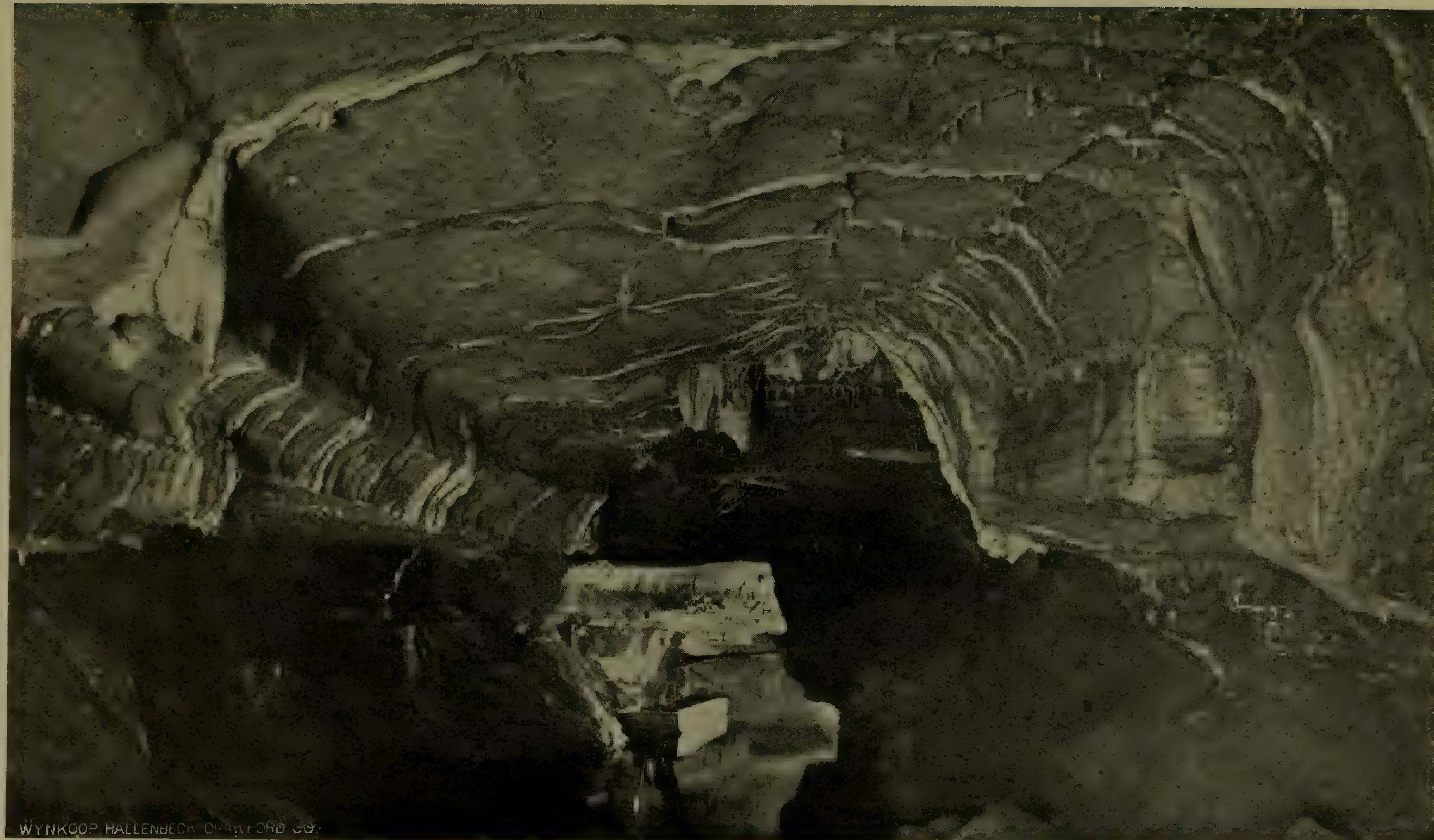
PLATE LXVIII.—To face page 158.



N. H. Darton, photo.

SINK IN THE LOWER HELDERBERG LIMESTONE WEST OF COXSACKIE, GREENE CO.

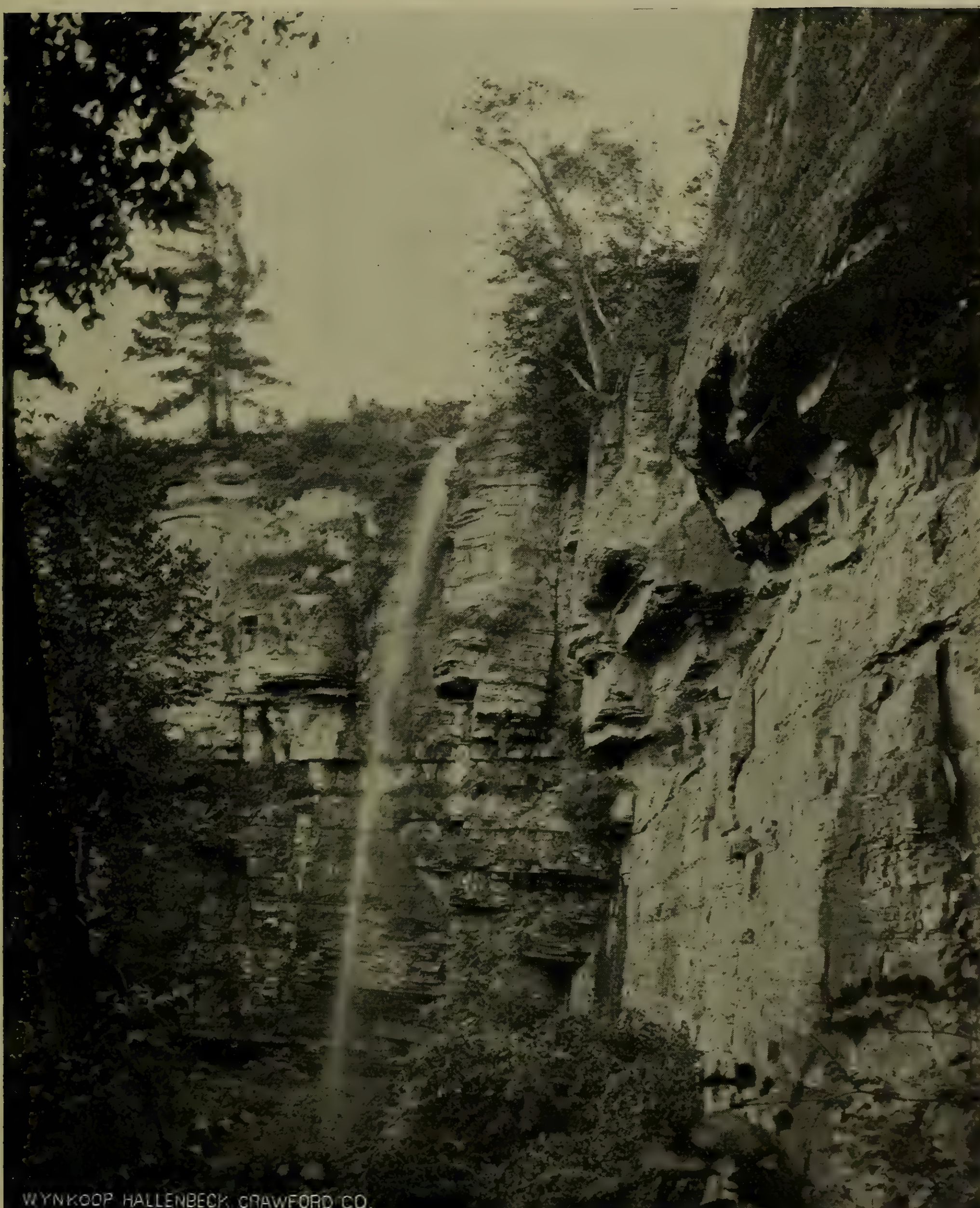
PLATE LXIX.—To face page 158.



S. R. Stoddard, photo.

INTERIOR OF HOWE'S CAVE, SCHOHARIE CO., SHOWING SUBTERRANEAN STREAM, STALACTITES, ETC. LOWER HELDERBERG LIMESTONE.

PLATE LXX.—To face page 158.



N. H. Darton, photo.

CLIFF OF LOWER PENTAMERUS LIMESTONE, NEAR INDIAN LADDER, ALBANY CO.

Oriskany sandstone

This rock which overlies the Lower Helderberg group, is, at Oriskany Falls, whence it derives its name, a coarse light colored sandstone about 20 feet thick. In localities further west it is sometimes, as at the falls of the Chittenango creek and at Split Rock near Syracuse, either wanting or represented only by a few inches of dark sandy rock; sometimes, as between Elbridge and Skaneateles, 30 feet thick; and in other localities, of various intermediate thicknesses. Near Schoharie, it contains some lime with its sand, and is light colored; in some parts of the Helderberg region, as near Clarksville, and Knox, it is only a foot or two thick, a hard, dark colored stratum full of fossils and having[a] on its upper surface myriads of impressions of the Spirophyton cauda galli. In Pennsylvania, it is from 150 feet to 300 feet in thickness, and contains the same organic remains which are found in it in New York.

Cauda Galli Grit

Above the Oriskany sandstone, in the Helderberg region, is a mass of sandy slate or shale, often more than fifty feet thick; but it is not known west of Herkimer county. In Pennsylvania, it is seen from the state line to the Water Gap. It is valuable as a road metal though not very durable and forms, by decomposing, a poor soil. It is equally barren in fossils, the only form known being what is called the Cocktail fucoid, Spirophyton cauda galli, supposed to be the remains of a marine plant, the form of which resembles the peculiar plumage from which it is named. The abundance of this fossil has given the rock in which it lies the name of ' Cauda galli grit.[b]

Schoharie Grit

Upon it lies the Schoharie grit, a thin mass, usually only four or five feet of hard calcareous sandstone, which, when freshly quarried, looks like a gray limestone, but when long weathered,

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a This important fact is not noted by either Mather or Lincklaen though it must have been observed by them. F. J. H. M.

b As I have noted under Oriskany, this fossil is not confined to the Cauda galli and occurs on the Oriskany sandstone. F. J. H. M.

loses its carbonate of lime and becomes a gritty yellowish sandstone. It is found only from Cherry Valley eastward, extending round the front of the Helderbergs and along the hills west of the Hudson, but does not appear to be known in Pennsylvania.

Upper Helderberg or Corniferous Limestone

This which lies above the Schoharie grit, Cauda galli grit and Oriskany sandstone, and where these are wanting, together with the Lower Helderberg, as in western New York, rests immediately on the waterlime group, is one of the most widely known and useful limestones of the state. The lower portion, from 10 to 20 feet in thickness, is generally a coarse-grained crystalline gray rock, and, when free from chert, working well under the hammer and chisel, and often taking a good polish as a marble. It is called, from being very extensively quarried in Onondaga county, the Onondaga Limestone. It is easily traced from near Rondout on the Hudson to the Helderbergs in Albany county, where its outcropping edge turns westward, and extends past Schoharie, Cherry Valley, Bridgewater, Oriskany falls, the falls of the Chittenango below Cazenovia, Split Rock, Auburn, Phelps, Le Roy, and Williamsville to Black Rock. Through nearly all this distance it preserves its well marked character, and is extensively used in building.

The upper portion of the group is what was originally called the Corniferous limestone, from its containing beds and nodules of hornstone or chert: it is usually from 30 to 50 feet thick, a bluish or grayish rock, often having some shale interstratified with it. Though these two portions of the Upper Helderberg limestone are in most places very distinct, yet in others, especially in the west, they seem to run together or blend in one mass; so that they are now regarded only as local varieties of a single rock.

Upper Devonian Rocks

In the Upper Helderberg group, we have the last or highest formation of limestone of any considerable extent or thickness in the state. All the southern counties, lying above or south of

PLATE LXXI.—To face page 160.

I. P. Bishop, photo.

Corniferous Limestone, Cayuga Creek, Bellevue, Erie Co. The Surface Shows the Dissolving Action of Water.

the line of outcrop of the Onondaga and Corniferous limestones as before described, are nearly destitute of this useful rock; being formed of vast deposits of slaty, shaly, and sandy strata, several thousand feet in thickness, the exposures of which extend southward from a few miles south of the Erie canal to beyond the Pennsylvania line.

These rocks give rise to peculiarities in the topographic features of the country which they underlie, and in its soil and vegetable productions. Containing little lime, the culture of wheat does not generally succeed well upon them; nor does the central wheat growing district extend over them for more than a few miles south of the limestone range, except in a few alluvial valleys, or places where calcareous materials from the limestone belts have been strewed over the southern shales by glacial action, of which we shall speak hereafter. Grazing and dairying are almost exclusively the pursuits of the farmer.

The most marked physical features of this great extent of country are its deep valleys and long hills, usually extending in a north and south direction, as an inspection of any map will show. Some of these long north and south valleys dammed by drift deposits are the basins of that remarkable series of lakes beginning with Otsego, and comprising Canaseraga, Cazenovia, Otisco, Skaneateles, Owasco, Cayuga, Seneca, Crooked, Canandaigua, Honeoye, Canadice, Hemlock, and Conesus; all so similar in general form and direction, and in the shape and geological formation of their enclosing hills. Over the whole extent of these rocks, the country is 'rolling,' or broken into ridges generally running north and south, and rising from one to eight hundred feet above the main valleys; and it is rarely that we find among them a plain half a mile wide, except in a few of the 'bottom-flats' or alluvial lands along the larger rivers, such as the Genesee.

These rocks are generally quite uniform in their character, especially in the eastern part of the state near the Hudson valley, and might be grouped into one enormous formation 5,000 feet or more in thickness, except for a few variations in texture, and

some more marked differences in the fossils of their lower, middle, and higher portions, on account of which they have been separated and described under the successive divisions of the Marcellus, Hamilton, Genesee, Portage, Chemung and Catskill.

Hamilton group

The Hamilton group, named from its exposure at Hamilton, Madison county, consists of the following sub-divisions.

Group	Stage	
Hamilton	Genesee	
	Tully	
	Hamilton	Moscow shale
		Encrinal limestone
		Ludlowville shale
	Marcellus	

Marcellus Shale

The lowest division, resting immediately on the Upper Helderberg limestone, was named from the village of Marcellus, near which it is well exposed. It is a mass of dark, fissile, short-fractured shale, one or two hundred feet in thickness, in most places containing layers of impure limestone and rounded concretions of similar material in its lower part.

At the village of Stafford in Genesee county, a thin limestone is well exposed about 40 feet above the base of the Marcellus. It has been called by Prof. J. M. Clarke, the Stafford Limestone, and extends from central New York to Lake Erie.

In Onondaga county the Goniatite limestone replaces the Stafford limestone.

These shales closely resemble those of the coal formation and sometimes contain thin seams of coaly or bituminous matter, which have misled many persons to spend considerable sums in digging and boring in them, with the illfounded expectation of finding useful layers of coal. This is an idle hope, for they lie thousands of feet below the Carboniferous system, beneath which no valuable coal strata have ever been found.

PLATE LXXII.—To face page 162.

I. P. Bishop, photo.

MARCELLUS AND HAMILTON SHALES, ATHOL SPRINGS, SHORE OF LAKE ERIE, ERIE CO.

PLATE LXXIII.—To face page 162.

Hamilton.

Marcellus.

I. P. Bishop, photo.

CLIFF OF DEVONIAN SHALES, SHORE OF LAKE ERIE, NEAR BAY VIEW, ERIE CO.

PLATE LXXIV.—To face page 162.

I. P. Bishop, photo.

EXPOSURE OF DEVONIAN SHALES, GORGE OF EIGHTEEN MILE CREEK, ERIE CO.

PLATE LXXV.—To face page 162.

Genesee.

Styliola layer.

Moscow shale.

Encrinal limestone.

I. P. Bishop, photo.

UPPER DEVONIAN ROCKS, GORGE OF EIGHTEEN MILE CREEK, NEAR LAKE VIEW, ERIE CO., ¼ MILE BELOW THE L. S. & M. S. R. R. BRIDGE.

Encrinal limestone.

I. P. Bishop, photo.

HAMILTON SHALES, SHORE OF LAKE ERIE, AT THE MOUTH OF EIGHTEEN MILE CREEK, ERIE CO.

PLATE LXXVII.—To face page 162.

Genesee. Moscow shale. Encrinal limestone.

Hamilton.

I. P. Bishop, photo.

DEVONIAN ROCKS. WANAKAH. SHORE OF LAKE ERIE, ERIE CO.

PLATE LXXVIII.—To face page 162.

N. H. Darton, photo.

DEVONIAN STRATA, HONK FALLS, NEAR NAPANOCK, ULSTER CO.

Hamilton Shale

The Marcellus shales change gradually at their higher part into the Hamilton shale which is a harder, lighter colored mass, often containing sandstones, and, in central New York and as far east as the Catskill range, is 1,000 feet or more in thickness. Like the Marcellus shale, many parts of it show few marks of stratification; but it is divided vertically by joints, which, where it is excavated, are often as upright and smooth as the walls of a plastered building. In the more eastern part of the state, it is generally coarse-grained and sandy; in western New York, it is fine-grained, soft and more calcareous, forming by its decomposition a rich soil.

In the survey of the fourth district Hall divided the Hamilton into three parts; at the base the *Ludlowville shale,* overlaid by the *Encrinal limestone* and at the summit the *Moscow shale.* The Ludlowville and Moscow horizons take their name from localities in western New York. The Encrinal limestone is named from its prevailing fossil.

Tully limestone

The Hamilton group terminates in central New York with a very impure dark limestone, about 10 feet thick, which received its name from the village of Tully in Onondaga county. In the eastern and western parts of the state this rock does not exist, as it extends only from Ontario county to Madison, and beyond these limits the Genesee slate lies directly on the Hamilton group. The Tully limestone contains some fossils which are common to it and the lower shales.

Genesee

The next rock in upward order is the Genesee, a series of layers of thin-bedded, fissile, black slate, in some places 150 feet thick, but diminishing westward so that it is only about 25 feet on Lake Erie. It is, however, distinctly recognized in Pennsylvania, where it is some 300 feet thick. It derives its name from one of its best localities in this state, the gorge of the Genesee river

below Portage. It is generally recognized by its black, soft, slaty texture, but its fossils are very rare.

Portage group

This name has been given to the next higher portion of the great slaty and shaly masses, which form the walls of deep gorge of the Genesee at Portage and cover everywhere on the south the Hamilton group and Genesee slates. This enormous pile of sandy, slaty and shaly strata is in some parts of the state 1,000 feet in thickness: it was divided by Prof. Hall into a lower mass called the Cashaqua shale, a middle mass called the Gardeau shale and flagstones, and a terminal mass of sandstones seen at Portage; but in middle and eastern New York, these divisions are not distinct.

Much of this group is a soft olive-colored shale; but its most useful portions are its layers of flagstone, which are largely quarried near Norwich and Ithaca, on the hills back of the Helderbergs, on those west of the Hudson river as far down as Rondout; and in Sullivan county near the Delaware river.

From Chenango and Broome counties eastward to Greene county the Portage is represented by the Oneonta formation which forms the lower 1,000 feet of the Catskill mountain strata.

The soft shales of the Portage group contain many of the concretions known as *Septaria*, which also occur in the Marcellus shales.

Chemung group

To the Portage succeeds the Chemung, so called from being well exhibited at the 'Narrows' of the Chemung river, near Waverly, in Tioga county. Its thickness of 1,000 or 1,500 feet is made up of a series of thin-bedded sandstones with intervening shales and occasional beds of impure limestone mainly formed by the materials of fossil shells. In many places it abounds with fossils. While well developed in central and western New York the Chemung, as a group of fine sediments, disappears to the eastward and is represented by the Catskill formation.

PLATE LXXIX.—To face page 164.

I. P. Bishop, photo.

ERODED DEVONIAN SHALES, SHORE OF LAKE ERIE, MOUTH OF PIKE CREEK, NEAR DERBY, ERIE CO.

PLATE LXXX.—To face page 164.

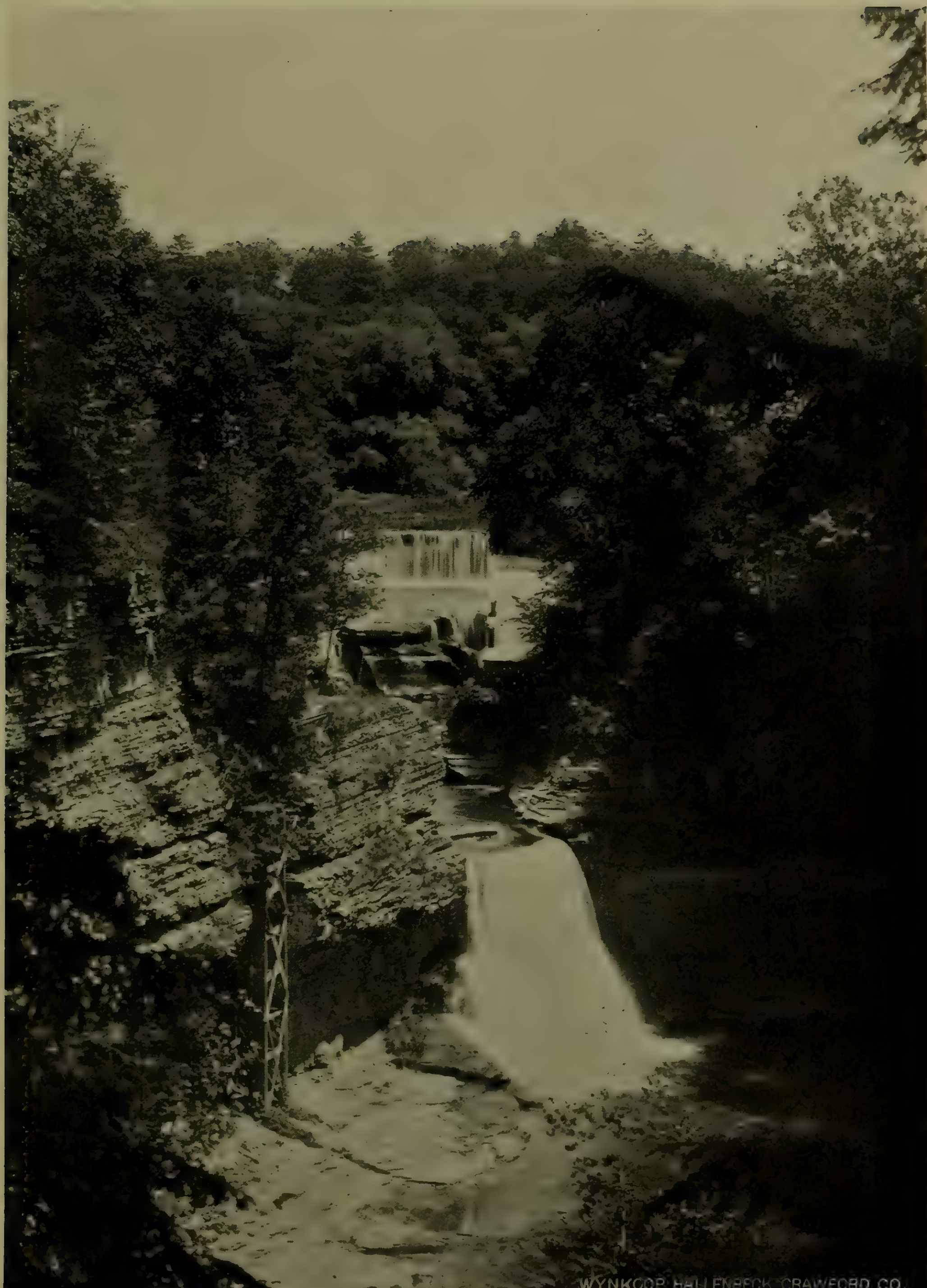
Cashaqua shale.

Genesee shale.

I. P. Bishop, photo.

Hamilton and Portage Shales, Shore of Lake Erie, Mouth of Pike Creek, Near Derby, Erie Co.

PLATE LXXXI.—To face page 164.



R. S. Tarr, photo.

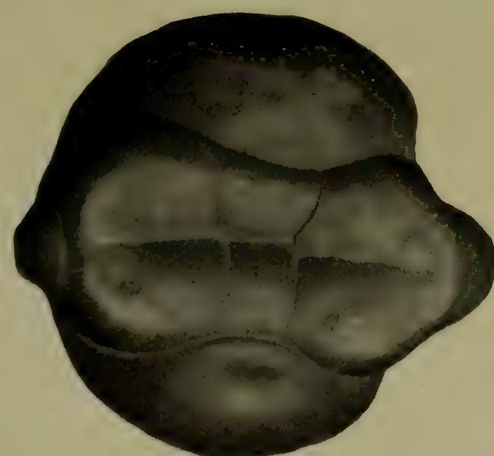
LOWER PORTAGE SHALES, TRIPHAMMER FALLS, ITHACA, TOMPKINS CO.

PLATE LXXXII.—To face page 164.

I. P. Bishop, photo.

BLACK SHALES, PORTAGE GROUP, PIKE CREEK, NEAR WEST FALLS, ERIE CO.

PLATE LXXXIII.—To face page 164.



14″ x 13″

18″ x 16″

Clay Iron Stone Concretions, Portage Group, Shore of Lake Erie.

PLATE LXXXIV.—To face page 164.

N. H. Darton, photo.

VIEW OF THE WITTEMBERG RANGE, SOUTHERN CATSKILLS, FROM A POINT HALF A MILE EAST OF SHOKAN STATION, ULSTER CO., LOOKING WEST.

RELIEF MAP OF THE EASTERN CATSKILL MOUNTAINS AND THE HUDSON RIVER VALLEY.

Catskill group

The Chemung passes or changes eastward into the Catskill, an enormous series of shaly and sandy strata, which covers all the upper range of the Catskill mountains, and many of the higher tracts of the southern counties as far west as Steuben. In the latter county it is only a thin mass of calcareous sandstone, and farther west it thins out and disappears entirely; but in the Catskill region it is probably 2,500 feet thick, and twice as much in Pennsylvania; whence it is found southward along the mountain ridges, but in thinner volume.

The beds of this series are varied in color, being greenish gray sandstones, fine-grained reddish sandstones, slates, shales, grindstone grits and an accretionary mass appearing like fragments of hard slate cemented in calcareous rock. The hard sandstone often weathers in a peculiar way, dividing into thin layers almost like piles of boards.

The fossils of this rock are very few. Recent studies of this group suggest that it is not entitled to distinct recognition but is equivalent to the Chemung and perhaps to the Portage. Remains of plants are numerous, forming occasionally tiny seams of coal; and in some localities are teeth, bones and scales of fishes. The latter are often conspicuous objects, as they are usually white or bluish in color, and contrast strongly with the red rock.

Life of the Devonian

In the Devonian is observed a marked general advance in the character of life on the globe.

Sponges were few. Brachiopods were varied and numerous. Mollusks were abundant. Corals were highly developed and very numerous.

Fishes were the dominant type and appear to have supplanted the immense cephalopods which ruled in the Lower Silurian seas.

Plant life was well represented on land, especially by ferns. Conifers also existed.

The abundant flora which gave rise to the coal formations of the Carboniferous first became prominent in the Devonian.

CARBONIFEROUS SYSTEM

This system took its name from the fact of its being the chief coal bearing formation of Europe.

The Carboniferous is not well represented in New York; some of the uppermost sandstones, shales and conglomerates near the Pennsylvania boundary are undoubtedly of this age, but they contain no fossils.

In the endeavor to identify the Carboniferous strata of New York, it has been necessary to take up the known strata of this age in Pennsylvania and trace them, so far as possible, into New York.

The gradation from the rocks of the Devonian to those of the Carboniferous is not abrupt. On either side of the assumed boundary plane are greenish gray shales and sandstones without distinctive characters. For the present purpose it is necessary to describe the succession of the Pennsylvania rocks and indicate their occurrence in New York.

Sub-Carboniferous, Pocono group

Above the uppermost Devonian sandstones lie the rocks which are considered to be the base of the Carboniferous system. They are mainly sandstones with occasional beds of conglomerate. This conglomerate is said to occur on some of the peaks of the Catskills, but it has not yet been recognized in southwestern New York.

Sandstones of Pocono age doubtless occur in New York near the Pennsylvania boundary but they have no fossils.

The Pocono formation attains a thickness of more than 2,500 feet in Pennsylvania on the Susquehanna river. Some thin seams of coal occur in it. It contains no fossils except fragments of plants.

Mauch Chunk group

The Pocono is succeeded by a formation called the Mauch Chunk group, which, in Pennsylvania, is about 3,000 feet in its greatest thickness, though far less in some districts. It is almost entirely composed of soft, red shales and argillaceous red sand-

stones seen in the northern counties and generally around the edges of the different coal fields. In southern Pennsylvania it includes limestones. This formation has not been recognized in New York.

Pottsville conglomerate

The Mauch Chunk red shale is covered by a thick series of strata, known as the Pottsville conglomerate. It is a gray and whitish conglomerate, in massive beds alternating with gray sandstones, and consists mainly of rolled and rounded quartz pebbles cemented with ferruginous sand into a solid mass. Some of its finer or more sandy layers often show lamination in a diagonal or slanting direction. It is 1,700 feet thick at its maximum and often contains one or more thin seams of coal; being the lowest horizon in which any considerable quantity of that mineral has yet been found. It is remarkably massive in its general appearance, the ledges often separating into huge blocks with wide fissures between, which have been fancifully compared to ruined cities. Such localities are to be seen in New York six miles south of Olean, seven miles south of Ellicottville and near Wellsville, where they are popularly called 'rock-cities.' This is locally known as the Olean conglomerate.

The 'rock cities' lie on high points not far from the Pennsylvania line and are simply remnants of the conglomerate left far north of the main body of the rock by the wear and tear of the elements, which, going on through ages, has worn away this massive stratum over a great extent of country. They are impressive monuments to the vastness of that erosion, which has left them in this isolated position and which will in the course of future centuries demolish them entirely.

This conglomerate is the highest and latest formed of all Palaeozoic rocks known within the limits of New York. In Pennsylvania it is the base of the 'Productive Coal-measures,' as the strata containing workable layers of coal are called. They are made up of thick beds of sandstones and black shale, with which the coal layers are interstratified. The coal strata are of all thicknesses, from a few inches up to 20 or even

100 feet, and are separated from each other by masses of rock from 10 or 20 to 200 or 300 feet thick, and are mined in various ways according to their situation.

Geologic investigation in all coal regions has led to the conclusion that the strata of coal are composed of vegetable matter, which during the Carboniferous epoch appears to have reached an enormous and luxuriant growth, and formed vast accumulations, which after being buried under the marine sediments of clay and sand which now form the shales and sandstones over them, underwent chemical changes which transformed them to their present condition. The proofs of this are found in the fact that the rocks above and below the coal seams are filled with vegetable remains, leaves, stems, roots, etc.; the trunks of the trees being in some places found still erect and standing upon their roots, but converted into coal; and that even the coal itself, though in most cases it is solidified into one mass so as to show no organic structure, displays in other instances, under the microscope, all the structure of wood; the cells, the ducts through which the sap once circulated, and even minute markings by which it can be determined whether the wood belonged to one or another general class of trees.

The vegetable origin of all coal is well established; but the mode in which great accumulations of it were made, over such vast areas, is yet an obscure question. A single bed of coal, that called the Pittsburgh seam, is known to extend over no less than 14,000 square miles, with a usual thickness of from four to ten feet. Other layers, though less in extent, are much greater in thickness, reaching even 100 feet. The prevailing opinion is that it grew in enormous morasses or swampy tracts, resembling on a larger scale the Great Dismal swamp, or the Okefinokee swamp of Georgia, in which the annual fall of leaves, branches, and trunks through a long period of time formed thick peaty masses, which, being submerged under the sea and covered with sediments, became the vast deposits of fossil fuel which are now of so great importance.

The fossils of the coal measures are almost entirely vegetable. In the slates above the coal seams, most perfect and beautiful impressions of leaves occur in profusion; and large trunks or stems are found, almost always compressed to a thickness of only an inch or two, though two feet or more in width. The greater part of these trees seem to have been allied to the tree-ferns of tropical climates, though there are remains of coniferous trees and several other vegetable families. The character of this fossil vegetation would seem to indicate that at the time it grew, a far warmer climate than that now known prevailed over the temperate and arctic zones.

The fact that coal is of vegetable origin, seems to explain why the lower rocks which form the state of New York contain no coal. *They appear to have been formed before terrestrial vegetation flourished to an extent sufficient to form accumulations of this substance.*

The first relics of land plants are found in the Upper Silurian; above this they become more numerous and in the Catskill group of the Devonian are quite abundant, forming occasionally miniature coal seams an inch thick.

In the Carboniferous rocks they increase suddenly to an enormous quantity, and in later formations are found in considerable, but generally in less abundance. Coal is also found in newer rocks, such as the Jurassic, Cretaceous and Tertiary. The coal or lignite beds of the central part of the continent near the Rocky mountains, belong to the Cretaceous and Tertiary rocks. The coal of Vancouver island on the Pacific coast is Cretaceous. The coal beds near Richmond, Virginia, are of Triassic age. The conclusions to be drawn from our present knowledge are that good coal is found *above* the Carboniferous system, but *never below it.*

Permian

This formation which is well developed in Europe, taking its name from the Province of Perm, in Russia, is not known to exist in New York state. It occurs in Texas and its vicinity. It has been suggested that some of the uppermost deposits commonly

known as Carboniferous in Pennsylvania, should be referred to this horizon.

Life of the Carboniferous

Animals

Foraminifera were abundant. Sponges were well represented. Reef building corals were scarce. Crinoids were abundant.

Brachiopods were large and numerous.

Mollusks were prominently represented by cephalopods.

The fishes of the Carboniferous were very numerous and were principally sharks and ganoids.

The presence of amphibians was the prominent feature in the life of the Carboniferous; their bones occur in the coal measures. The largest were about the size of alligators.

Before the close of the Carboniferous, reptiles appeared.

Plants

Vegetable life was well represented by ferns, lycopods, equisetae, conifers and cycads. These were the plants which supplied the vegetable tissue which forms the coal beds.

Mesozoic Time

The Mesozoic presents a marked contrast to the Palaeozoic. The sea was peopled with fishes. Cephalopods were most prominent among the mollusks. True reptiles which appeared in the Permian were large and numerous and reached their highest development. Mammals appeared as a new element but held a subordinate position. They were at first quite small.

There was a complete change in the vegetation. Sigillaria and calamites disappeared and the age of gymnosperms succeeded that of acrogens or pteridophyta.

Arborescent conifers were very large and abundant. The cycads occupied the place of the palms of the present day.

The Mesozoic series includes the *Triassic*, *Jurassic* and *Cretaceous* systems.

TRIASSIC SYSTEM

This system received its name in Germany where it consists of three distinct members. In England it is known as the New Red Sandstone and contains the salt deposits of that country. West of the Mississippi river the Triassic is well represented in the United States, but in the east it is found only in narrow troughs on the east side of the Appalachian chain and approximately parallel to it. It is well developed in the Connecticut valley and is again found near Stony Point, New York, from which locality it extends southwest across Rockland county into New Jersey, thence through Pennsylvania and Virginia. In the latter state it includes the Deep and Dan river coal basins which are of considerable importance.

The Triassic deposits of New York and New England were apparently formed in estuaries and consist of shales and sandstones. These bear ripple marks, sun cracks, rain prints and the foot prints of enormous biped reptiles with three toes. These were at first supposed to be bird tracks. Fishes are also abundant in the sandstones of New York and New Jersey.

The eastern Triassic rocks are important as having furnished the greater part of the brown sandstone, which is used so extensively for building houses in our eastern cities. The Triassic period was also characterized by eruptions of igneous rock, which formed the well known trap dykes of Connecticut and New Jersey. In the latter state the most prominent is that known as the 'Palisades of the Hudson,' which extend along the west shore of the Hudson river from Staten Island to a point northwest of Nyack. At the level of the river the rock is a nearly horizontally stratified red sandstone; but between the bedding planes a vast volume of melted rock has been injected, and in cooling has assumed the rudely crystalline or columnar structure so common in basaltic or trap rocks. The broken edge of this enormous sheet of trap, fronting on the river, forms the precipice so well known as 'the Palisades.' The Orange mountains are also of the same formation.

Life of the Triassic period

In the Triassic was the reign of the amphibians, some of which were very large. The most highly developed was the labyrinthodon, which had the form of a frog and was as large as an ox. Reptiles were very large and numerous but their remains are more abundant in Europe than America. The mammalian fauna was insignificant; fishes were numerous; mollusks were abundant, but were not a prevailing type.

JURASSIC SYSTEM

The connection between the Triassic and Jurassic is very close and the passage is very gradual. The Jurassic takes its name from the Jura mountains of France and Switzerland, which are chiefly composed of the rocks of this age. In eastern North America the Jurassic is moderately developed, and it is considered that a part of the Triassic sandstone, already described, may have been deposited during this age.

West of the Mississippi the Jurassic is well developed.

Life of the Jurassic period

The Jurassic was especially characterized by the prominence of reptilian life which appeared in a great variety of forms and occupied every place in nature. Reptiles were large and numerous, in the ocean and on land. Even in the air immense lizards with wings like those of a bat were abundant. In this age the first of the birds appears. This was the *archaeopteryx*, found in the slates of Solenhofen, Germany, a bird which was rudimentary in its development. The wings were short and also the wing feathers which were radiated. The tail was vertebrated and the vertebrae bore feathers. It had no teeth. The sharks and ganoid fishes were large and abundant. The mammals were numerous, but subordinate in rank, not being larger than rats and opossums.

In this system also was the culmination of the ammonite family, a group of coiled cephalopods named from their resemblance to the horns on the statues of Jupiter Ammon. As the cephalo-

PLATE LXXXVI.—To face page 172.

H. Ries, photo.

TRIASSIC CONGLOMERATE, STONY POINT, ROCKLAND CO.

PLATE LXXXVII.—To face page 172.

Triassic
Diabase.

H. Ries, photo.

View Northward Along the Palisades of the Hudson River, from Fort Lee, N. J.

PLATE LXXXVIII.—To face page 172.

Triassic Diabase.

S. R. Stoddard, photo.

THE PALISADES OF THE HUDSON. VIEW NORTHWARD FROM ENGLEWOOD CLIFFS, N. J.

J. N. Nevius, photo.

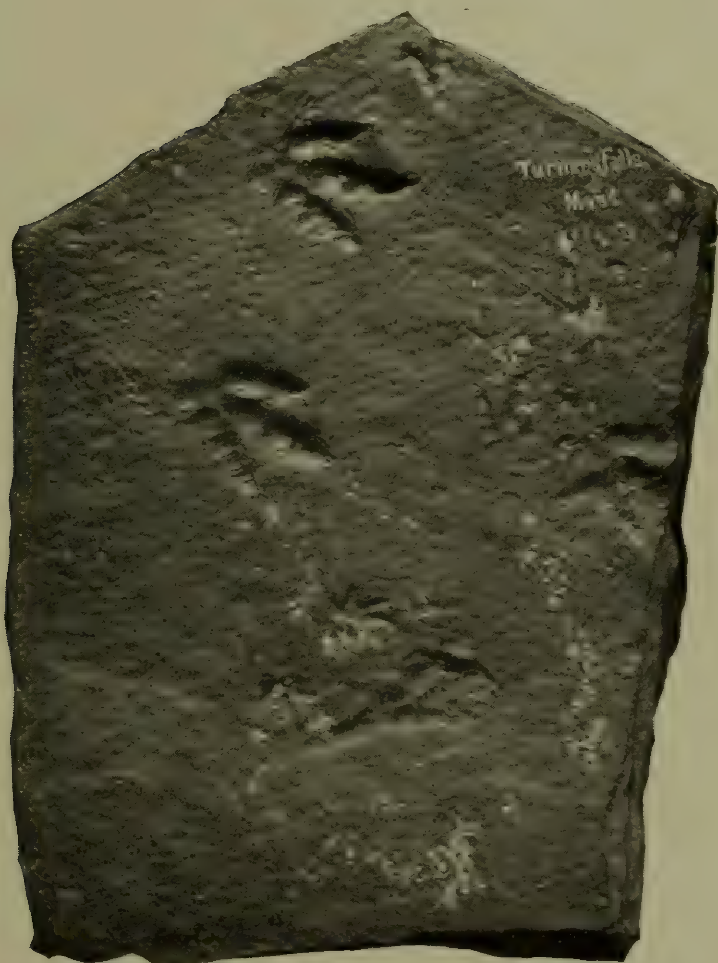
TRIASSIC DIABASE EXPOSED IN A CUT FOR THE ORANGE MOUNTAIN CABLE-ROAD, ORANGE, N. J.

PLATE XC.—To face page 172.

H. Ries, photo.

CONTACT OF TRAP AND UNDERLYING TRIASSIC SANDSTONE, SOUTH END OF LANE'S QUARRY, FORT LEE, BERGEN CO., NEW JERSEY.

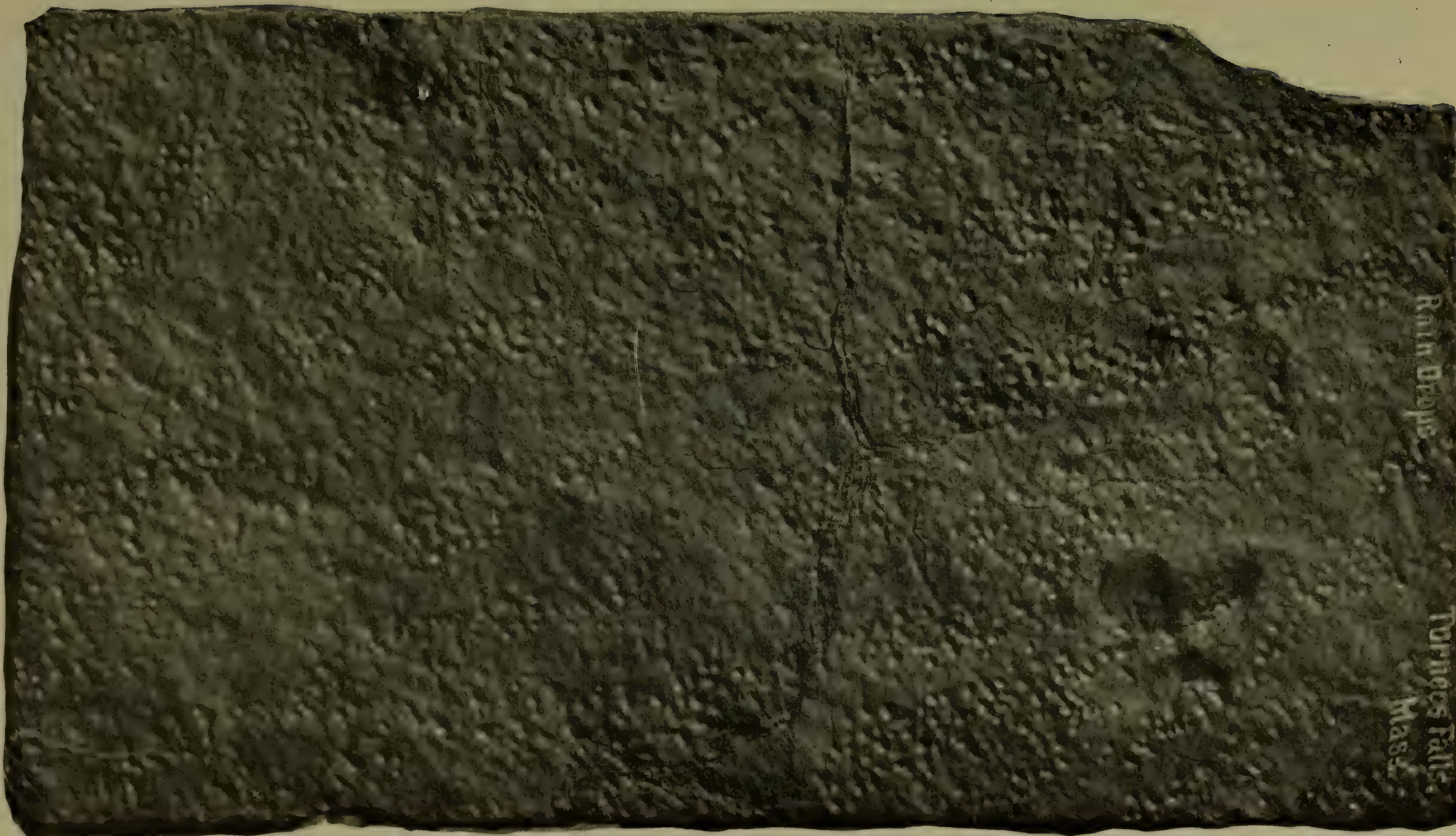
PLATE XCI.—To face page 172.



J. N. Nevius, photo.

REPTILIAN FOOTPRINTS ON TRIASSIC SANDSTONE, TURNER'S FALLS, MASS. ORIGINAL SLAB 19 INCHES BY 27 INCHES.

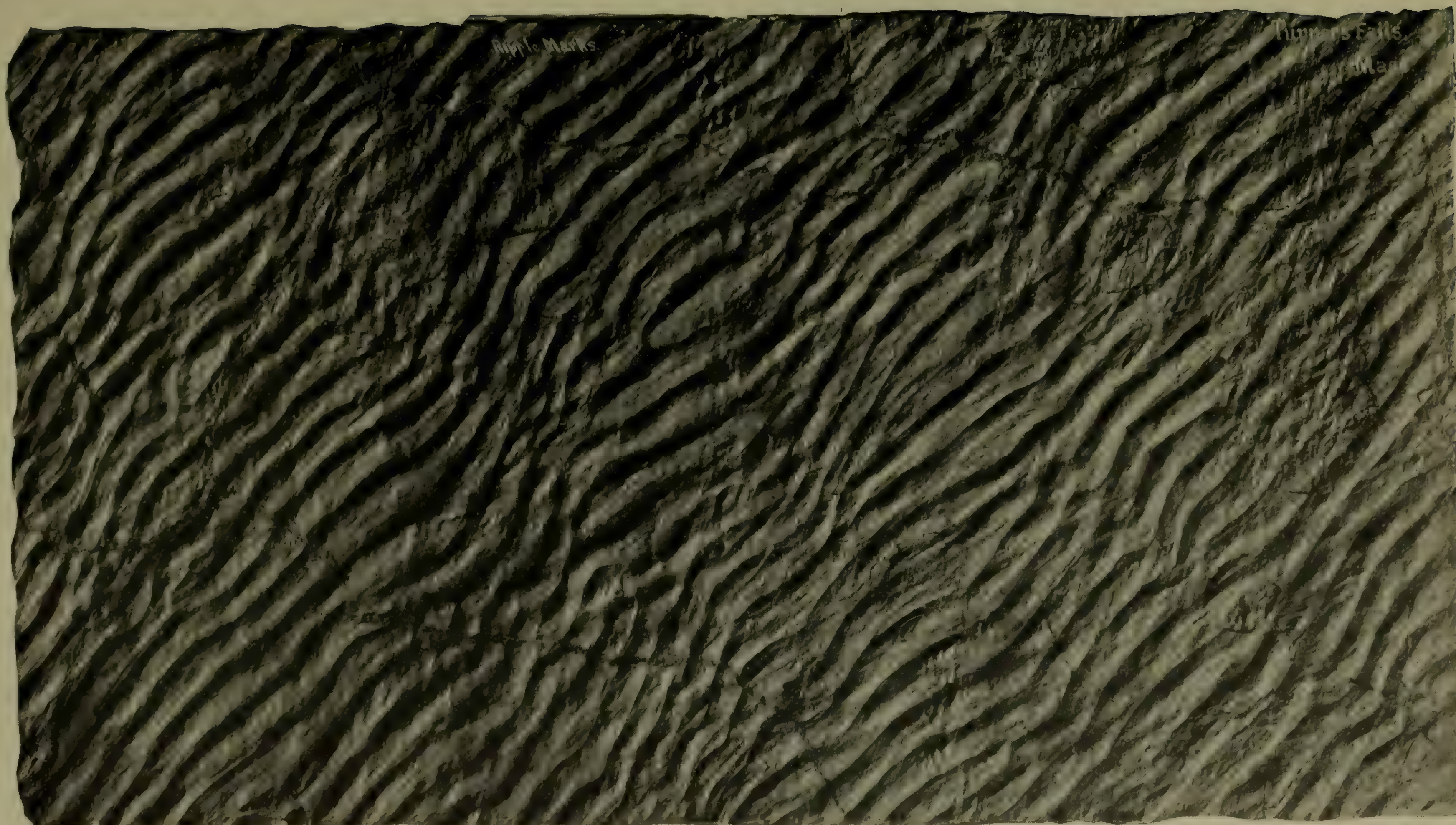
PLATE XCII.—To face page 172.



J. N. Nevius, photo.

Rain Prints and Reptilian Footprints on Triassic Sandstone, Turner's Falls, Mass. Original Slab 33 Inches by 18 Inches.

PLATE XCIII.—To face page 172.



J. N. Nevius, photo.

RIPPLE MARKS ON TRIASSIC SANDSTONE, TURNER'S FALLS, MASS. ORIGINAL SLAB 43 INCHES BY 24 INCHES.

pods were represented in great development by the orthoceras in the Lower Silurian seas, so were they represented by the ammonite in the Jurassic. The orthoceras disappeared after the Triassic age.

The smaller mollusks were also abundant and began to assume more nearly the features of those which occur at the present day. At this time the oyster made its appearance.

CRETACEOUS SYSTEM

The Jurassic system was succeeded by the Cretaceous. This received its name in Europe from the chalk formation, which in England and France is very prominent, being several hundred feet thick. The chalk is a limestone which has not been consolidated. If it had been exposed to the same agencies as the Palaeozoic limestones it would probably like them have been consolidated to form a hard rock. A large part of the chalk consists of skeletons and shells of foraminifera, some of the species being found in the ocean at the present day. With these foraminifera, which are mostly calcareous, are the remains of other minute animals called polycystines which are silicious and also the spicules of sponges. These, by some chemical action, have been gathered together and consolidated into nodules of flint which is a variety of quartz similar in composition to the hornstone of the Corniferous and other limestones. Hornstone is also called chert and has furnished the material for most of the North American Indian arrow-heads which are commonly called flint arrow-heads. As a matter of fact the true flint does not occur in America and technically American flint arrow-heads are made of chert or hornstone. It is not impossible, however, that early traders from England may have supplied our Indians with flint from Europe.

In America there is but little chalk, although the Cretaceous system is largely developed. It extends from the Gulf of Mexico to the Arctic ocean in a belt 200 miles wide. On the Atlantic coast Cretaceous deposits are found beneath the Tertiary and consist chiefly of sand and clay. The clays which occur on Long

Island and are well represented from Staten Island to the vicinity of Camden, New Jersey, are important in the manufacture of pottery. Some of the clay beds contain plant remains and about 50 species of land plants have been recognized here. Among these are many genera which exist at the present day, such as the cinnamon, sassafras, oak, gum etc. The character of this vegetation suggests that a temperate climate prevailed in this region during cretaceous time. A little later, in the Tertiary, a sub-tropical climate prevailed in what are now the Arctic regions. West of the Mississippi the Cretaceous deposits of our country are divided into three principal groups; the *Dakota*, which consists of sandstone and conglomerate with beds of clay; the *Colorado*, a group of limestone and bituminous shales; and the *Laramie*, which is a bed of passage into the Tertiary and contains important deposits of lignite, a variety of coal.

Life of the Cretaceous period

In the Cretaceous, mammals were still insignificant. The members of the ammonite group of the cephalopoda, were numerous and varied in form. The other mollusks were closely allied to those of the present day. Many bony fishes appeared and supplanted the ganoid fishes which had previously prevailed. The reptilian fauna was prominent, but became greatly diminished before the tertiary. With the close of this period occurred a great change in the life of the globe.

Cenozoic Time

Following the close of the Mesozoic age begins the Cenozoic, which includes the Tertiary and Quaternary systems and is characterized by a marked resemblance of its life, to that of the present day.

TERTIARY SYSTEM

Sir Charles Lyell divided the European Tertiary into three parts; the Eocene, Miocene and Pliocene. The Eocene was estimated to contain about 10% of living species, the Miocene about 50% and the Pliocene about 90%, but these percentages are not of world wide application.

The Tertiary of our Atlantic slope consists chiefly of sands and clays, which in the southern states are well developed. A much larger development occurs west of the Mississippi river on the sites of extinct Tertiary lakes. Marine Tertiary is also found on the Pacific coast.

In New York state the Tertiary is not accurately identified and is indivisible, but is probably represented by sands and gravel on Staten Island and Long Island. There is comparatively little marine Tertiary in North America, as the northern part of the continent was out of water at that time. The Tertiary beds west of the Mississippi are chiefly fresh water deposits formed in lake basins. The Tertiary was a period of mountain making. In southern Europe the great chains of mountains known locally as the Pyrenees, Alps, Apennines and Carpathians, consist to a large extent of Tertiary rocks. This is also true of the Himalaya mountains of India. It is known that extensive disturbances in our Appalachian system occurred during the Tertiary.

Life of the Tertiary period

Birds and mammals succeeded the reptiles of the cretaceous. Of the mammals all the orders now existing were represented. Reptiles were not more numerous than at present and were similar to existing genera. Fishes were very abundant. Insects were many and varied. Mollusks were abundant; oysters occurred in great variety and of enormous size. Corals were not plentiful. Land plants were very abundant and very similar to those of the present day; the cypress grew in the Arctic regions.

QUATERNARY SYSTEM

At the close of the Tertiary a cold temperate climate reigned in the United States and a great ice age began, during which the northern part of our continent was covered with a sheet of ice many hundred feet thick. The chief evidences of this are the inscriptions of the continental glaciers on the rocks in the shape

of grooves and polished surfaces and the material transported by it.

The glacial phenomena are well marked. Ice worked blocks of stone have a peculiar angular form, which does not occur on water worn boulders.

The theory of continental glaciation was first worked out in Europe from studies of the glaciers of the Alps. These are the result of a copious precipitation of moisture on the mountains in the form of snow and the formation of snow ice. Large masses of this consolidate and form ice rivers or glaciers, which slowly move toward the valleys grooving and polishing the rocks over which they pass and tearing off rock fragments, which in turn are polished and scratched as they are dragged along in the base of the ice.

Glaciers now exist in Iceland, Greenland and Alaska and in other Arctic countries, also on some of the mountains of Washington, South America, Asia and Africa. They also abound within the Antarctic Circle.

Evidences of former continental glaciation occur in both hemispheres.

In New York state the continental glacier extended as far south as Long Island and Staten Island and formed at its front a great ridge of transported rock debris, sand, gravel, boulders and clay, at some points over 360 feet in height, which is called the 'terminal moraine' and is known locally as the back bone of Long Island.

After reaching its point of maximum extension and resting there, perhaps for a long time, the ice sheet with a recurrence of a warmer climate began to retreat. This retreat was not at an even rate. There were periods of arrested motion and probably of temporary advance as shown by the moraines of recession. These are masses of earth, gravel and boulders which form small hills and ridges.

As the ice melted, great volumes of water were poured over the land and the valleys were flooded. The streams thus formed were loaded with sand and gravel which they carried for a dis-

PLATE XCIV.—To face page 176.

I. P. Bishop, photo.

GLACIAL SCRATCHES ON THE CORNIFEROUS LIMESTONE, CHEEKTOWAGA, ERIE CO.

PLATE XCV.—To face page 176.

H. Ries, photo.

QUATERNARY DELTA DEPOSIT OF CROTON RIVER, 1 MILE SOUTH OF CROTON LANDING, WESTCHESTER CO.

PLATE XCVI.—To face page 176.

J. N. Nevius, photo.

VIEW OF QUATERNARY KAME DEPOSIT, NORTH ALBANY, ALBANY CO.

PLATE XCVII.—To face page 176.

J. N. Nevius, photo.

SECTION OF QUATERNARY SAND AND GRAVEL BEDS, NORTH ALBANY. ALBANY CO., SHOWN IN LAST ILLUSTRATION.

PLATE XCVIII.—To face page 176.

J. N. Nevius, photo.

VALLEY OF EROSION, IN THE QUATERNARY SAND PLAIN, NEAR DELMAR, ALBANY CO.

PLATE XCIX.—To face page 176.

N. H. Darton, photo.

LAKE IN QUATERNARY DRIFT HILLS SOUTHWEST OF GLENS FALLS, WARREN CO. FRENCH MOUNTAIN IN THE DISTANCE.

PLATE C.—To face page 176.

H. Ries, photo.

QUATERNARY PLAIN AT THE FOOT OF THE HELDERBERG ESCARPMENT, BETWEEN RAVENA AND SOUTH BETHLEHEM, ALBANY CO.

PLATE CI.—To face page 176.

J. N. Nevius, photo.

Valley of the Normanskill, Near Albany, Albany Co., Carved by the Stream Through a Plain of Quarternary Sands. Crescent Shaped Lake was Formed by Natural Diversion of the Stream into a New Channel.

PLATE CII.—To face page 176.

I. P. Bishop, photo.

SAND BARS, LAKE ERIE, MOUTH OF EIGHTEEN MILE CREEK, ERIE CO.

PLATE CIII.—To face page 176.

I. P. Bishop, photo.

Glacial Boulders Washed from Moraine, Stony Point, Near West Seneca, Erie Co. Shore of Lake Erie.

PLATE CIV.—To face page 176.

S. R. Stoddard, photo.

FOOT OF THE SELKIRK GLACIER, BRITISH COLUMBIA, SHOWING THE FORMATION OF A MORAINE DEPOSIT.

tance and dropped to form the flood plains and terraces which border our river valleys and the hills of sand and gravel in the valleys which are called kames and eskers. Where there were bodies of still water the finer materials were dropped to form clay.

At this time the country was deeply submerged and tide water filled the valley of the Hudson river and Lake Champlain so that the Gulf of St Lawrence and New York harbor were united. This is evidenced by the fact that near the St Lawrence and Lake Champlain, above the gravel beds, are some beds of clay 200 feet thick or more, which contain marine shells of species now existing on the coasts of New England and Canada. These show that, since such shells were living, those valleys have been depressed below the sea-level, long enough for these deposits of clay to be formed. They are known as pleistocene clays. The Hudson river valley clays are their southern extension, but contain no fossils.

The Quaternary deposits of New York are, therefore, chiefly those made in the presence of the ice and those resulting from the working over of the glacial deposits by running water. In this latter process the angularity of the glacial boulders and pebbles has been worn off. The evidences of glacial action are well seen in almost all parts of this state. Almost every gravel-bank consists of waterworn fragments of the old rocky strata; pebbles of limestone, sandstone and slate, with some of gneiss and granite, which universally appear to have been transported from north to south. From a bushel of pebbles taken from any gravel bank south of the Erie canal, the geologist can pick out specimens of almost every stratum which is exposed north of the bed whence they were taken. South of the line of outcrop of the Helderberg limestones, the gravels are full of fragments of their different layers; and among them lie worn pieces of the red Medina sandstone, others of the Hudson river group, and others of still more northern strata; while some are granite pebbles, which must in many instances have come from Canada. They have evidently been transported from north to south in

vast quantities; they are smooth-worn, and are smaller the farther they are found from their original strata; they are generally found in irregular layers with sand and clay, as if left so by the action of rapid currents of water. One of the most interesting facts connected with them is, that they have been in many cases transported from lower to higher levels, even up steep acclivities and over high hills. There are spread with them also (but generally lying on the surface of the ground) many large and heavy masses of loose rock, called boulders. Some of these are limestones or sandstones, the origin of which can easily be traced to thin native strata within the state; others are granitic masses, which must have come from beyond Lake Ontario, in the same manner that the peculiar crystalline rocks of the Adirondack mountains are found to have been carried south beyond the Mohawk valley. The surfaces of the rocky strata in all the country, over which these 'drift beds' have passed, are in many places found to be worn smooth, and scratched or furrowed in a general north and south, or northwest and southeast direction, as if heavy materials had been dragged or driven over them.

Quaternary fossils

Among the most recent of the fossil remains, which link together the vanished forms of the past with the living animals of to-day, are the bones of the mastodon and fossil elephant, which are occasionally disinterred in various parts of the state, found buried only in recent accumulations of muck, peat, or other earthy materials. They are relics of a very modern period of geologic history, and these immense animals seem to have lived during the existence in this region of many of our still-remaining wild animals; possibly even since it was inhabited by man. Specimens of the mastodon have been found at Cohoes, at Batavia and in Orange county. In addition to these may be mentioned the *Castoroides ohioensis*, a gigantic extinct species of beaver, which was probably of the same period with the mastodon. A skull of this species was found near the village of Clyde, in earth, during the excavation of a canal. Remains of a reindeer have been found at Sing Sing.

The petrified wood, leaves, moss, etc., which are common in our limestone districts, are of modern date, and are forming at the present time. The rain-water which percolates through the crevices of the limestone rocks, by means of the carbonic acid which it gathers from the air, dissolves the carbonate of lime; and on coming again to the air in springs, re-deposits it in the form of tufa, a drab-colored mass which is nearly pure carbonate of lime. This, as it gradually forms, incrusts the leaves, sticks, etc., with which it comes in contact; and often, as they decay, replaces them in such a manner as to present the same form and structure; pieces of wood being thus replaced by a stony mass closely resembling the original substance.

Age of man

Man is the most highly specialized member of the animal kingdom. His remains are not found in deposits earlier than the post glacial, which appear to have an age of not many thousand years. There is, so far, no clue to his origin. The first relics of man are rude implements of stone or bone such as knives, arrow-heads, etc., and are found in the gravels of streams and in caves.

The first period of man is known as the stone age, but though it ceased long ago in Europe, in North America it has existed to within the present century. The bronze age succeeded the stone age. Last of all came the age of iron which is the present.

PRESENT SURFACE OF NEW YORK

Under this head it is important to consider briefly the causes which have reduced so large a portion of the rock strata of New York, from the original condition of the wide and uninterrupted extent in which they were formed to that of an undulating and broken aggregate of hills and valleys which we now see. It is probable that during the slow process of emergence from their native sea, the action of waves and currents wore them deeply

and extensively; and since they were uplifted to their present elevation, the elements have unremittingly acted upon them.

As the rocks, newer than the Carboniferous, occur in but small areas within our state, it may be concluded that the greater part of this region has been above water since the Carboniferous period, during the countless ages while the Triassic, Jurassic, Cretaceous and Tertiary rocks were formed and during the deposition of which the animated population of the earth has been changed many times. All of these formations were made of sediments worn from pre-existing land. It is to be expected, therefore, that this ancient land should show the marks of vast erosion and wear. Some marks of this are found in the long and deep valleys which traverse the state, all of which have been worn out of the solid strata, the remaining portions of which form the adjacent hills. These valleys are being worn deeper where the rivers are strong and their cutting action continues, and everywhere they are being widened and the mountains and hills reduced in height by rains and frost. Some valleys have been excavated much below the level of their present outlets, so that they retain the drainage and form the remarkable series of finger lakes previously mentioned.

Vast as the work may seem, the fact is plain that not only have these valleys been formed by erosion, but hundreds of feet of rocky strata have been removed from the summits of the hills themselves and from large tracts of plain country. The whole vast basin of Lake Ontario is an excavation in rocks which still lie nearly as level as when first deposited; and there seems no reason to doubt that the northern edges of the enormous thickness of formations above the Helderberg limestones once overspread the present lowlands of the counties bordering that great body of water.

Such long lines of bluffs as the Niagara 'mountain ridge,' and the steep escarpments of the Helderberg limestones, are evidences of the great work of erosion. The existence of old beaches, such as the Lake Ridge near Rochester, proves that the waters of the lake once stood far higher than now.

Part 3.

ECONOMIC GEOLOGY

Building Stone [a]

GRANITIC ROCKS

Granite, Gneiss, Syenite, Trap and Norite

Granite. Typical granite is a crystalline, granular mixture of a feldspar, quartz and hornblende. In addition to these essential constituents, one or more accessory minerals may be present. The more common are the micas, muscovite and biotite, garnet, tourmaline, magnetite and pyrite. The character of the rock is often determined by the presence of these accessory constituents in quantity, as in some cases the hornblende is entirely replaced by mica.

The chemical composition also varies from that of the average or typical kind. The mineralogical differences mark the varieties, thus there are: hornblende granite, biotite granite, tourmaline granite, etc.

The texture of granites is determined by the aggregated minerals entering into their composition. It varies from coarse-crystalline, in which the individual crystals may be an inch or more in length, to fine-crystalline and aphanitic, wherein the minerals are hardly visible to the eye. In consequence of the wide variation due to the mode of arrangement of the mineral constituents, there is an equally great variety noticeable in the texture.

The color also is dependent upon the minerals. As feldspar is the predominant constituent it gives character to the mass, and the red varieties owe their color to the red or pink feldspars in them, as in the case of the granite of Grindstone Island in the St Lawrence. The shades of gray are due to the varying

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[a] This chapter on building stone is abridged with alterations and additions from Bulletin No. 10 of the New York State Museum, by John C. Smock.

amount of the dark colored mica mixed with the feldspar and quartz; and the dark colored varieties owe their color, in most cases, to hornblende or tourmaline which may be present.

The beauty, ease of working, durability and value of the granites for use in construction is related closely to their mineralogical composition. Their arrangement in the mass and their relative proportions determine the color and give beauty. The presence or absence of certain species influence the hardness and homogeneous nature and the consequent ease with which the stone can be dressed and polished. For example the mica, if disposed in parallel surfaces, gives a foliated structure and tends to produce what is known as rift, and the granite is more readily split in the planes of the mica than across them. Again the mica flakes may be so large and irregularly massed that the surface is not susceptible of a uniform degree of polish. Hornblende, on account of its superior toughness, is less brittle than pyroxene under the polishing, and the hornblende granites are said to be preferred to those rocks which contain pyroxene in quantity.

The more nearly alike in hardness and the more intimately interwoven the texture of the minerals, the more capable they are of receiving a good polish. Hence it follows that the very coarse crystalline granites are not so well suited for ornamental work.

The enduring properties of granites vary with the nature of the minerals in their composition. Although popularly they are regarded as our most durable building stone, there are some notable exceptions, which are evident in the natural outcrops, where this rock is found decayed to the depth of 100 to 200 feet, and in the active disintegration which is in progress in structures of the present century. Foliated varieties placed on edge in buildings, tend necessarily to scale under the great changes of temperature in our northern cities and towns. The more rapid decomposition of the micas makes those varieties in which they occur in large flakes or aggregations more liable to decay. The condition of the feldspar also is often such as to influence the durability. When kaolinized in part, it is an element of weakness rather than of strength. The presence of the easily decom-

PLATE CV.—To face page 182.

H. Ries, photo.

GRANITE QUARRY, ROUND ISLAND, NEAR PEEKSKILL. WESTCHESTER CO.

posable varieties of pyrite is not only prejudicial to strength and durability but also to the beauty of the stone as soon as it begins to decay.

The term 'granite' as used among builders and architects is not restricted to rock species of this name in geologic nomenclature, but includes what are known as gneisses (foliated and bedded granites), diorites, gabbro and other crystalline rocks whose uses are the same. In fact, the similar adaptability and use have brought the latter species into the class of granites. For example, the Au Sable granite of Essex county is a norite. The term is applied in some cases to the diabases or trap-rocks, as the 'granite quarries' of Staten Island.

Another massive crystalline rock which is used in building is norite, consisting of labradorite and hypersthene, with some brown mica. It is a common rock in the Adirondack region, and is known commercially as a granite.

The massive crystalline rocks are of common occurrence in New York, but not in outcrops over extensive areas, excepting in the Adirondack region and in the Highlands of the Hudson. The schistose crystalline rocks are developed extensively in the Highlands of the Hudson and on the borders of the Adirondack region. On New York island and within the city limits the gneiss rocks have been quarried at many points. In Westchester county there are belts of gneiss and mica schist, in which quarries have been opened near Hastings; near Hartsdale, east of Yonkers; at Kensico; at Tarrytown and at Ganung's, west of Croton Falls. In Putnam county there are quarries of granite near Peekskill, Garrison's and Cold Spring. West of the Hudson river there are quarries on Iona island; at West Point; on Storm King mountain, near Cornwall; near Suffern; at Ramapo; and on Mount Eve, near Florida. The outcrops of the gneissoid and granitoid rocks are so numerous in the belt of the Hudson Highlands that quarries can be opened at many points. The supply of stone is inexhaustible. On the Hudson river, between Peekskill and Fishkill, there is a fine section of these rocks exposed.

On the borders of the Adirondack region quarries have been opened in the towns of Wilton, Hadley and Greenfield, in Saratoga county; at Whitehall, in Washington county; at Littlefalls, in Herkimer county; Grindstone Island, Jefferson county; and near Canton in St Lawrence county. The inaccessibility of much of this region and the distance from the large city markets have prevented the opening of more quarries in the gneissic rocks on the borders of the Adirondacks.

TRAP

Trap-rock or trap is the common name given to a class of eruptive rocks because of a structural peculiarity, and has no distinctive significance in mineralogical composition. The rocks of the Palisade mountain range and of the Torn mountain, which extends from the New Jersey line, on the west shore of the Hudson river to Haverstraw, are known as trap-rocks. There is an outcrop on Staten Island, at Graniteville, near Port Richmond, where a large amount of stone has been quarried at the so-called 'granite quarries.'

The trap-rock of the Palisades range is a crystalline, granular mass of plagioclase feldspar (usually labradorite) augite and magnetite. It is generally finer crystalline than the granite. The colors vary from dark gray through dark green to almost black.

This trap-rock is hard and tough, but some of it is split readily into blocks for paving. It has been used extensively in New York and adjacent cities for street paving, but since the introduction of granite blocks this use has nearly ceased. On account of its toughness it makes an admirable material for macadamizing roadways. It is so hard that only rock-face blocks are used in constructive work. Several prominent buildings in Jersey City and Hoboken are built of it. There is a large quarry on the river at Rockland lake, near Haverstraw, the output of which is for street work and road material almost exclusively. There are also quarries at Piermont and at Graniteville, Staten Island.

SANDSTONE

Sandstone consists of grains of sand which are united by a cement.

The grains may be of varying sizes, from almost impalpable dust to small pebbles, and may be angular or more or less rounded in form. The cementing matter also may vary greatly in its nature. From this variation, both in the grains and in the cement, there is an almost endless gradation in the kinds of sandstone.

Quartz is the essential constituent, but with it there may be feldspar, mica, calcite, pyrite, glauconite, clay or other minerals, and rock fragments common to stone of sedimentary origin. These accessory materials often give character to the mass, and make a basis for a division into feldspathic, micaceous, calcareous sandstones, etc.. as one or another of them predominates.

The texture of the mass also is subject to a wide range of variation, from fine-grained, almost aphanitic, to pebbly sandstone, or conglomerate, or a brecciated stone in which the component parts are more or less angular.

Some of the brown sandstones of the Triassic age, quarried near Haverstraw, are such conglomeratic and brecciated sandstones. Accordingly, as the grains are small or large, the stone is said to be fine-grained or coarse-grained.

The variety of the cementing material also affords a basis for classification. Silicious sandstones have the grains bound together by silica. They consist almost exclusively of quartz, and grade into quartzite. The ferruginous varieties have for their cement an oxide of iron, often coating the grains and making a considerable percentage of the whole. The iron is usually present as ferric oxide. Calcareous sandstones are marked by the presence of carbonate of lime. When it exceeds the quartz in amount, the sandstone becomes a silicious limestone. In the argillaceous varieties, the binding material is a clay, or an impure kaolin.

The cementing material determines in most cases the color. The various shades of red and yellow depend upon the iron

oxides; some of the rich purple tints are said to be due to oxide of manganese.

The gray and blue tints are produced by iron in the form of ferrous silicate or carbonate. By an irregular association of masses of different colors a variegated surface is produced, or by an alternation of white and variously-colored laminæ a striped appearance is given to the mass.

Sandstones occur stratified and in beds of greater or less thickness, and they are said to be thick-bedded or thin-bedded. In some cases the beds are so thick, and the stone of such a uniform texture, that the stone can be worked equally well in all directions, and is known as *freestone.* A laminated structure is common, especially in the thin strata, or when the stone is micaceous. When the beds can be split into thin slabs along planes parallel to the bedding, it is called a *flagstone.* A less common structure is what is termed lenticular or wedge-shaped, in which the upper and under surfaces lack parallelism, and the beds wedge out. It makes the quarrying more difficult, and produces more waste material.

The variations in the nature of the component grains, and binding material, in their arrangement, and in the forms of bedding, produce a great variety of stone, and the gradations from one to another are slight. The hardness, strength, beauty and durability are determined by these varying elements of constitution. The stone best resisting the action of the atmospheric agencies is that in which the quartz grains are cemented by a silicious paste, or in which the close-grained mass approaches in texture a quartzite.

The presence of mineral liable to decomposition, as feldspar highly kaolinized, of mica, marcasite, and pyrite, of calcite in quantity, and clays, affects the durability and tends to its destruction.

Sandstones are classified according to their geologic age also. They are found occurring in all the series, from the oldest to the most recent formations. Those of a given age are generally

marked by characteristic properties, which serve for their identification, aside from the fossil organic remains by which their exact position in the geologic series is fixed. This persistence in characters is exemplified in the Medina sandstones, in the Devonian bluestone, and in those of Triassic age.

Sandstones occur in workable quantity in nearly all the greater divisions of the state.

Quarries have not, however, been opened everywhere in the sandstone formations, because of the abundant supply of superior stone from favorably situated localities. There are, in consequence, large sandstone areas and districts in which there is an absence of local development, or abandoned enterprises mark a change in conditions, which has injuriously affected the quarry industry.

Following the geologic order of arrangement and beginning with the Potsdam sandstone, the several sandstone formations are here briefly reviewed.

Potsdam sandstone

This formation is the oldest in which, in this state, sandstone is quarried for building purposes.[a]

The bottom beds are of fine, silicious conglomerate; above are sandstones generally in thin beds. It is gray-white, yellow, brown and red in color. In texture it varies from a strong, compact quartzite rock to a loosely coherent, coarse-granular mass, which crumbles at the touch.

Outcrops of limited area occur in the Mohawk valley. In the Champlain valley the formation is well developed at Fort Ann, Whitehall, Port Henry and Keeseville, and quarries are opened at these localities. The stone is a hard, quartzose rock, and in thin beds. North of the Adirondacks the formation stretches westward from Lake Champlain to the St Lawrence; and there are quarries in the towns of Malone, Bangor and Moira in Franklin county; in Potsdam and Hammond in St Lawrence county;

[a] Some of the sandstones east of the Hudson and in the Taghkanic range may belong to the Lower Cambrian. See *Amer. Jour. of Science*, series III, vol. 35, pp. 399-401. But there are no quarries opened in these localities.

and in Clayton, Jefferson county. In parts of Clinton county the stone is too friable for building.

The most extensive openings are near Potsdam; the stone is hard, compact and even-grained, and pink to red in color. Some of it has a laminated structure and striped appearance. It is an excellent building stone and is widely known and esteemed for its beauty and durability.

The Hammond quarries produce a gray to red stone. Nearly all of the output is cut into paving blocks and street material.

Hudson river sandstone

Rocks of this group outcrop in Orange county, northwest of the Highlands and in the valley of the Hudson river northward to the Champlain valley in Washington county. From the Hudson westward, the Mohawk valley is partly occupied by them. The belt increases thence in breadth, in a northwest course across Oneida, Oswego and Lewis counties, and continues to Lake Ontario.

The rocks consist of shales interbedded with sandstones and silicious conglomerates.

The sandstones are generally fine-grained and of light-gray or greenish-gray color. They are often argillaceous and not adapted for building purposes. But the even-bedded and well-marked jointed structure makes the quarrying comparatively easy, and the nearness to lines of transportation, and to the cities of the Hudson and Mohawk valleys have stimulated the opening of quarries at many points.

For common rubble work and for local use, the quarries in this formation have furnished a large amount of stone. The more important quarrying centers are now at Rhinecliff-on-the-Hudson, New Baltimore and Troy, in the Hudson valley; at Aqueduct, Schenectady and Duanesburg, Schenectady county; and Frankfort Hill, Oneida county. Flagstones are quarried from this formation in the gorge of the Bozenkill a few miles northwest of Altamont, Albany county.

PLATE CVI.—To face page 188.

J. N. Nevius, photo.

POTSDAM SANDSTONE, CLARKSON'S QUARRY, 3 MILES SOUTH OF POTSDAM, ST. LAWRENCE CO.

Oneida conglomerate

This formation is developed to its greatest thickness in the Shawangunk mountain in Orange and Ulster counties.

It is recognized in the Bellevale and Skunnemunk mountains, also, in Orange county. In the central part of the state it is traced westward in a narrow belt from Herkimer county into Oneida county. The prevailing rocks are gray and reddish-gray, silicious conglomerates and sandstones, which are noted for their hardness and durability. The cementing material is silicious. The jagged edges and angular blocks and the polished and grooved surfaces of the glaciated ledges, so common on the Shawangunk range, afford the best proof of the durable nature of these rocks. The bottom beds, near the slate, contain some pyrite. No attempt has been made to open quarries for stone, excepting at a few localities for occasional use in common wall work. The grit rock is quarried near Esopus creek for millstones, and at Ellenville is crushed for glass sand.

The accessibility of the outcrops to the New York, Lake Erie and Western railroad, the New York, Ontario and Western railroad, the West Shore railroad and the Delaware and Hudson canal lines is an advantage, as well as the comparative nearness to New York. No other formation in the state exhibits in its outcrops better evidence of ability to resist the weather.

Medina sandstone

The Medina sandstone is next above the Oneida conglomerate. It is recognized in the red and gray sandstones and the red and mottled (red and green) shales of the Shawangunk and Skunnemunk mountains in Orange county. A large amount of the red sandstone has been quarried on the north end of the Skunnemunk range, in the town of Cornwall, for bridge work on the railroads which cross the range near the quarry.

The red sandstone is seen exposed in the cuts of the Erie railway northeast of Port Jervis. This formation reappears in Oswego county, and thence west to the Niagara river in a belt bordering Lake Ontario.

Quartz is the principal mineral constituent associated with some kaolinized feldspar. The cementing material is mainly oxide of iron, with less carbonate of lime. The stone is even-bedded and the strata dip gently southward. The prevailing systems of vertical joints, generally at right angles to one another, divide the beds into blocks, facilitating the labor of quarrying.

Quarries have been opened at Fulton, Granby and Oswego, in Oswego county; at several points in Wayne county; at Rochester, on the Irondequoit creek, and at Brockport, Monroe county; at Holley, Hulburton, Hindsburg, Albion, Medina and Shelby Basin, in Orleans county; and at Lockport and Lewiston, in Niagara county. The Medina sandstone district proper is restricted to the group of quarries from Brockport west to Lockport.

The leading varieties of stone are known as the Medina red stone, the white or gray Medina and the variegated (red and white) or spotted. The quarries in this district are worked on an extensive scale, and their equipment is adequate to a large annual production. The aggregate output is larger and more valuable in dimension stone for dressing than that of any other quarry district in the state. Including the stone for street work, the total value is greater than that obtained from the stone of any other geological formation in the state. The stone has gained a well-deserved reputation for its value as a beautiful and durable building material; and its more general employment, both in construction and in paving, is much to be desired. The extent of the outcrops offers additional sites for quarrying operations, and the greater use of this stone, and the increase of the producing capacity of the district are here suggested.

Clinton group

The rocks of this group are shales, thin beds of limestone and shaly sandstones. They crop out in a narrow belt from Herkimer county west to the Niagara river and bordering the Medina sandstone on the south. Sandstone for building has been quarried in the southern part of Herkimer county; at Clinton, near Vernon

and at Higginsville in Oneida county, from this formation. The nearness of the Medina sandstone, with its more accessible quarries and superior stone, has prevented the more extensive development of the quarrying industry in the sandstone of the Clinton group.

Oriskany sandstone

The Oriskany sandstone formation is best developed in Oneida and Otsego counties. The rock is hard, silicious and cherty in places, and generally too friable to make a good building stone. No quarry of more than a local importance is known in it.

Cauda galli grit and Schoharie grit

These rocks are limited to Schoharie and Albany counties and to a very narrow belt which stretches south and thence southwest to Ulster county. The Cauda galli sandstones are argillaceous and calcareous and are not durable. They are used in Albany county for road metal, but are not very good for this purpose. The Schoharie grit is generally a fine-grained, calcareous sandrock which also is unsuited for building. Quarries in these rocks have local use only.

Marcellus shale

As its name implies, this formation is characterized by shaly rocks, which are not adapted to building. The abundance of good building stone in the next geologic member below it—the Corniferous limestone—whose outcrop borders it on the north throughout the central and western parts of the state, also prevents any use which might be made of its stone. A single quarry was at one time opened in it at Chapinville, Ontario county.

Hamilton group

The rocks of the Hamilton group outcrop in a narrow belt, which runs from the Delaware river, in a northeast course, across Sullivan and Ulster counties to the Hudson valley near Kingston; thence north, in the foot-hills, bordering the Catskills, to Albany county; then, bending to the northwest and west across the Helderberg mountains into Schoharie county; thence increas-

ing in width, through Otsego, Madison and Onondaga counties, forming the upper part of the Susquehanna and Chenango watersheds; thence west, across Cayuga, Seneca, Ontario, Livingston, Genesee and Erie counties to Lake Erie. In this distance there is some variation in composition and texture. In the western and central parts of the state there is an immense development of shales and the few quarries in the sandstone referable to this group are unimportant. In the Helderberg region in the Hudson valley and thence, southwest, to the Delaware river, the sandstones predominate, and all of the beds are more sandy than at the west.

Bluestone

There is a great development of the bluish-gray, hard, compact and even-bedded stone, which is known as 'Hudson river bluestone.'

This is a variety of sandstone, which, by reason of its even texture can be cut or sawed into any desired form and is therefore peculiarly available for house trimmings of various kinds. The sandstone is usually interbedded with shale and in general, the layers in the quarries vary from an inch to several feet in thickness; the thinner of these are used for flagstones and the thicker are cut into dimension stones for building purposes.

The geological horizon of the commercial bluestone is very near the dividing line between the Hamilton and Portage groups. It is, however, not usually possible to determine in which of these groups a given quarry belongs, owing to the great scarcity of fossils.

The bluestone industry is chiefly located in Ulster county and the quarries are almost innumerable but the business is controlled by a few large dealers who are located at points favorably situated for shipment and who, to a considerable extent, buy stone from the men who quarry it. Bluestone is also produced in the counties of Albany, Greene, Sullivan, Delaware and Chenango in Eastern New York and in Cattaraugus and Wyoming counties in Western New York.

The number of quarries is large and can be increased indefinitely, as nearly the whole area of the formation appears to be capable of producing stone for flagging or for building. The difficulty of indicating the division line between the Hamilton and the Oneonta and the Hamilton and the Portage groups of rocks makes it impossible to refer to localities more particularly. The quarries near Cooperstown, and in the lake region, particularly at Atwater, Trumansburg, Watkins and Penn Yan belong to the Hamilton group.

Portage group

In this is included the Oneonta sandstone, the limits of which at the east can not be indicated; the flagstone beds of the Hudson valley and of the eastern part of the State continue up into the Oneonta sandstone horizon. Many of the quarries are in the latter formation. The more western and northwestern and higher quarries are in it; and some of the Chenango county quarries also.

The Portage rocks in the western part of the State consist of shales at the base; then shales and flagstones; and the Portage sandstone at the top. In the last division, thick beds with little shale are marks of this horizon. The stone is generally fine-grained. The quarries near Portage and near Warsaw are in it; also the quarries at Laona and Westfield in Chautauqua county.

Although not of as great extent in its outcrop as the Hamilton group, the Portage rocks are developed to a thickness of several hundred feet along the Genesee river at Mount Morris and at Portage; and form a belt having a breadth of several miles through Tompkins, Schuyler, Yates, Ontario and Livingston counties, and thence west to Lake Erie. The formation is capable of supplying an immense amount of good building stone and flagstone throughout its undeveloped territory.

Chemung group

The rocks of the Chemung group crop out in the southern tier of counties, from Lake Erie eastward to the Susquehanna. The shales are in excess of the sandstones in many outcrops, and there

is less good building stone than in the Portage horizon. The variation in color and texture is necessarily great in the extensive area occupied by the Chemung rocks, but the sandstones can be described as thin bedded, generally intercalated with shaly strata, and of a light-gray color, often with a tinge of green or olive-colored. The outcropping ledges weather to a brownish color. Owing to the shaly nature of much of the sandstone of the Chemung group, the selection of stone demands care, and the location of quarries where good stone may be found is attended with the outlay of time and money, and with great chances of possible failure. Quarries have been opened near the towns and where there is a market for ordinary grades of common wall stone, and also for cut stone, but the larger part of their product is put into retaining walls. At Elmira and Corning good stone has been obtained, which is expensive to dress, and does not compete for fine work with sandstones from districts outside of the State. The quarries at Waverly, Owego, Elmira and Corning, and nearly all of the quarries in Allegany, Cattaraugus and Chautauqua counties are in the Chemung sandstone.

Catskill group

As implied in the name, this formation is developed in the Catskill mountain plateau in the eastern part of the state. Sandstones and silicious conglomerates predominate over the shales. The thicker beds of sandstones are generally marked by oblique lamination and cross-bedding, which make it difficult and expensive to work into dimension blocks. Except for flagging and for local use but little is quarried. There are no large towns in the district, and consequently the demand is light. There are, however, some good quarries, which are worked for flagging, chiefly along the New York, Ontario and Western railroad and the Ulster and Delaware railroad lines in Ulster and Delaware counties; and in the Catskills, in Greene county, there are quarries in Lexington, Jewett, Windham, Hunter and Prattsville.

Triassic formation

This formation, which is known, locally, as the red sandstone, is limited in New York to a triangular area in Rockland county, between Stony Point on the Hudson and the New Jersey line, and to a small outcrop near the north shore of Staten Island, which is the southern end of the same belt.

The sandstones are both shaly and silicious, and the varieties grade into one another. Conglomerates of variegated shades of color also occur, interbedded with the shales and sandstones. Formerly these conglomerates were in favor for the construction of furnace hearths. They are not now quarried. The prevailing color of the sandstone is dark-red to brown, whence the name 'brownstone.' In texture there is a wide variation, from fine conglomerates, in which the rounded grains are somewhat loosely aggregated, to the fine, shaly rock and the 'liver rock' of the quarrymen. Oxide of iron and some carbonate of lime are the cementing materials in these sandstones.

The well-known Massachusetts Longmeadow sandstone and the Connecticut brownstone are obtained from quarries in the Connecticut valley region, and of the same geological horizon. The Littlefalls, Belleville and Newark freestones are from the same formation in its southwest extension into New Jersey.

Quarries were opened in this sandstone more than a century ago, and many of the old houses of Rockland county are built of it. Prof. Mather reported 31 quarries on the bank of the Hudson near Nyack. The principal market was New York city, and the stone was sold for flagging, house trimmings and common walls. The Nyack quarries have been abandoned, with one or two exceptions, as the ground has become valuable for villa sites and town lots. There are small quarries at Suffern, near Congers Station, near New City and at the foot of the Torn mountain west of Haverstraw. They are worked irregularly and for local supplies of stone. The stone is sometimes known as 'Nyack stone,' also as 'Haverstraw stone.'

SLATE

Argillite, clay-slate, or roofing slate, which is marked by the presence of cleavage planes, and can be split into thin plates of uniform thickness, is a characteristic rock in the Hudson river group and the Lower Cambrian or Georgian group.

Slate suitable for roofing has been found in many localities, and quarries have been opened in Orange, Dutchess, Columbia, Rensselaer and Washington counties. The openings in Orange county have not resulted in productive quarries. In Columbia county quarries were worked many years ago, east of New Lebanon. The Hoosick quarries, in Rensselaer county, were once more extensively worked, and produced a good, black slate. Outcrops of red slate are noted east of the Hudson, from Fishkill and Matteawan northward, but no attempts have been made to open quarries in them.

The productive slate quarries of the state are in a narrow belt, which runs a north-northeast course through the towns of Salem, Hebron, Granville, Hampton and Whitehall in Washington county.

This slate belt is divided by the quarrymen into four parallel ranges or 'veins,' which are: East Whitehall red slates; the Mettowee, or North Bend red slate; the purple, green and variegated slates of Middle Granville; and the Granville red slates. The latter are close to the Vermont line. Further to the east, but over the state line, in Vermont, is the range of the sea-green slates.

The quarry localities are at Shushan, Salem, and Black Creek valley, in the town of Salem, Slateville, in Hebron, Granville, the Penrhyn Slate Company's quarries, Middle Granville, Mettowee or North Bend quarries, and the Hatch Hill quarries in East Whitehall.

LIMESTONE AND MARBLE

Limestones consist essentially of calcium carbonate. They are, however, often quite impure; and the more common accessory constituents are silica, clay, oxides of iron, magnesia, and bitumi-

nous matter. These foreign materials may enter into their composition to such an extent as to give character to the mass, and hence they are said to be silicious, argillaceous, ferruginous, magnesian, dolomitic, and bituminous.

The chemical composition is subject to great variation, and there is an almost endless series of gradation between these various kinds. Thus, the magnesium carbonate may vary in quantity from a trace, to the full percentage of a typical dolomite. Or, the silica may range from a fractional percentage to the extreme limit where the stone becomes a calcareous sandstone. Crystallized minerals, as mica, quartz, talc, serpentine and others, also occur, particularly in the more crystalline limestone.

In color there is a wide variation—from the white of the more nearly pure carbonate of lime through gray, blue, yellow, red, brown, and to black. The color is dependent upon the impurities.

The texture also varies greatly. All limestones exhibit a crystalline structure under the microscope, but to the unaided eye there are crystalline and massive varieties. There are coarse crystalline, fine crystalline, and sub-crystalline varieties, according as the crystals are larger, smaller, or recognized by the aid of a magnifying glass only. The terms coarse-grained and fine-grained may apply when there is a resemblance to sandstone in the granular state of aggregation. Other terms, as saccharoidal (like sugar), oolitic, when the mass resembles the roe of a fish; crinoidal, made up of the stems of fossil crinoids, also are in use, and are descriptive of texture. The state of aggregation of the constituent particles varies greatly, and the stone is hard and compact, almost like chert, or is loosely held together and crumbles on slight pressure, or again it is dull and earthy as in chalk.

The crystalline, granular limestones, which are susceptible of a fine polish, and which are adapted to decorative work, are classed as *marbles*. Inasmuch as the distinction is in part based upon the use, it is not sharply defined and scientific. Generally the term is restricted to those limestones in which the sediments have been altered and so metamorphosed as to have a more or

less crystalline texture. There is however some confusion in the use of the terms, and the same stone is occasionally known as marble and limestone, e. g., the Lockport limestone or marble; the limestone and coral shell marble of Becraft's mountain, near Hudson; the Lepanto marble or limestone near Plattsburg, and others.

The fossiliferous limestones are made up of the remains of organisms which have grown in situ, as for example, the coralline beds in the Helderberg and Niagara limestones, or have been deposited as marine sediments. In the case of the latter the fossils are more or less comminuted and held in a calcareous matrix. Generally the fossil portions of the mass are crystalline. The Onondaga gray limestone from near Syracuse, and the Lockport encrinal limestone are good examples.

The fossil remains are less prominent and scarcely visible in some of the common blue limestones, as in the lower beds of Calciferous and in some of the Helderberg series. These rocks are compact, homogeneous and apparently uncrystalline and unfossiliferous. They are usually more silicious or argillaceous, that is, they contain quartz or clay, the latter often in seams rudely parallel with the bedding planes. On weathering, the difference in composition is often markedly apparent at a glance. Similar differences in composition are seen in the more crystalline marbles, and are evident either by variation in color, or in the presence of foreign minerals, as mica, quartz, hornblende, pyrite, etc.

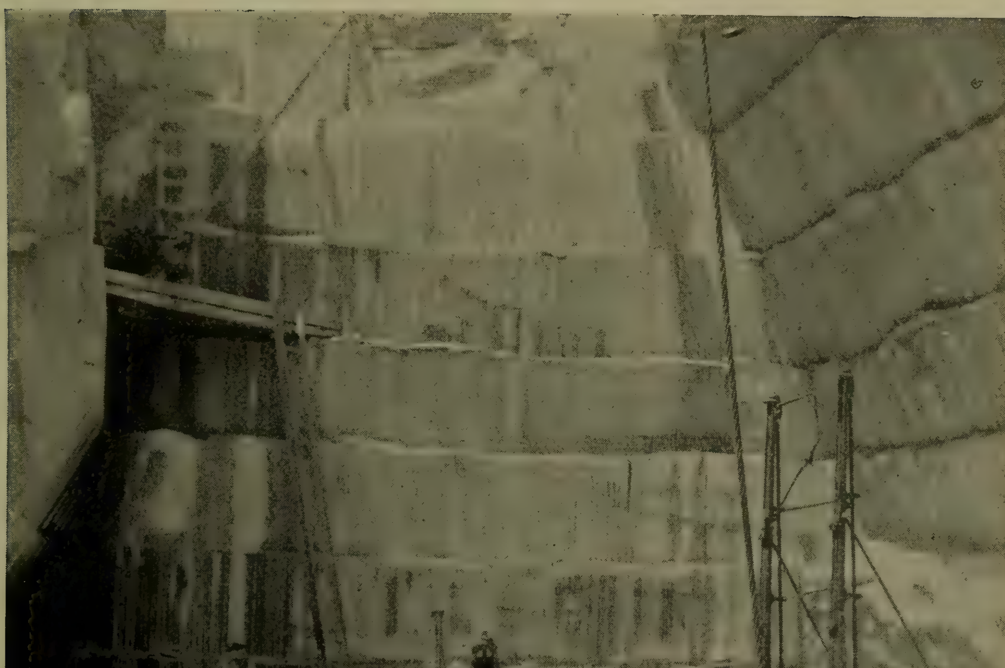
The variations in the strength and durability is as great as in the composition and texture. Some are stronger than many granites in their resistance to crushing force, and equally enduring; others consist of loosely cohering grains, and are friable and rapidly dissolved by atmospheric agencies. The more silicious and compact limestones are generally the more durable and stronger; in the marble the well-crystallized and more homogeneous texture consists with endurance and strength. Both the magnesian and dolomitic varieties are good stone as is proven by the Calciferous and the Niagara limestones, and in the marbles of Tuckahoe and Pleasantville, in Westchester county.

PLATE CVII.—To face page 198.

H. Ries, photo.

Marble Quarry, Tuckahoe, Westchester Co. Metamorphosed Calciferous-Trenton Limestone.

PLATE CVIII.—To face page 198.



J. N. Nevius, photo.

INTERIOR OF NORTHERN NEW YORK MARBLE CO.'S QUARRY, NEAR GOUVERNEUR, ST. LAWRENCE CO. PRECAMBRIAN.

Crystalline limestones occur in New York and Westchester counties, and in the Highlands of the Hudson. In the Adirondack region there are numerous localities. The rock in many of them is too impure and has too many foreign minerals to admit of its use as marble. Quarries have been opened in Westchester, Putnam and Dutchess counties, which have yielded a large amount of fine white marble. In the northern part of the state, the Port Henry and the Gouverneur quarries have been productive. The geological horizon of some of these marbles is in doubt. The belt in the eastern part of Dutchess and Putnam counties belongs to the Vermont marble range, and is probably metamorphosed Trenton limestone. The Westchester marbles are of the same age.

The limestones which furnish building stone in this state are the Calciferous, Chazy, Birdseye, Black river, Trenton, Niagara, Lower Helderberg, Upper Helderberg, or Corniferous, and Tully. The geographical distribution is given in the following notes, and in the order of geological succession, from the lowest to the highest.

Calciferous sandrock

The rocks of the Calciferous formation in the Mohawk valley and in the Champlain valley are more silicious than at the southwest, in Orange county and in the Hudson valley, and hence the designation as a sandrock. Much of it at the north is a limestone rather than a sandstone, and may be termed a magnesian or silicio-magnesian limestone. Nearly all of the limestones, which are quarried for building stone, in Orange and Dutchess counties are from this formation. The stone occurs generally in thick and regular beds. It is hard, strong and durable and is adapted for heavy masonry as well as for fine cut work. The quarries near Warwick, Mapes' Corners and near Newburgh in Orange county and those on the Hudson river, near New Hamburg, are in the Calciferous. The Sandy Hill quarry and those at Canajoharie and Littlefalls are also in it.

Trenton limestone

Under this head the Chazy, Birdseye, Black river and Trenton limestones are included.

The Chazy limestone crops out in Essex and Clinton counties and in the Champlain valley—its typical localities. The beds are thick and generally uneven. Regular systems of joints help the quarrymen in getting out large blocks. Quarries at Willsboro Point and near Plattsburg are in the horizon of the Chazy. The stone is suitable for bridge work and for heavy masonry.

The members of the Trenton above the Chazy limestone are recognized in may outcrops in the southeastern part of the state; in the Hudson-Champlain valley; in the Mohawk valley; in the valley of the Black river and northwest, bordering Lake Ontario; and in a border zone on the north of the Adirondacks, in the St Lawrence valley. In a formation so widely-extended there is, as might be expected, some variation in bedding, texture and color. Much of the Trenton limestone formation proper is thin-bedded and shaly and unfit for building stone. In the Birdseye also the stone of many localities is disfigured on weathering, by its peculiar fossils. Generally the stone is sub-crystalline, hard and compact and of a high specific gravity and dark-blue to gray in color. But the variation is wide, as for example, between the black marble of Glens Falls and the gray, crystalline rock of the Prospect quarries near Trenton Falls. The variation is often great within the range of a comparatively few feet vertically; and the same quarry may yield two or more varieties of building stone. In several quarries the Birdseye and Trenton are both represented. Many quarries have been opened in the formation and there are many more localities where stone has been taken from outcropping ledges, which are not developed into quarries proper. The more important localities which are worked steadily are: Glens Falls, Amsterdam, Tribes Hill, Canajoharie, Palatine Bridge and Prospect in the valley of the Mohawk; and Lowville, Watertown, Three Mile Bay, Chaumont and Ogdensburg in the Black river and St Lawrence valleys. The railroad and canal lines, which traverse the territory occu-

pied by these formations, afford transportation facilities and offer inducements to those who are seeking new quarry sites where these limestones may be found in workable extent.

Niagara limestone

The Niagara limestone formation is well developed west from Rochester to the Niagara river; and there are large quarries in it at Rochester, at Lockport and at Niagara Falls. The gray, sub-crystalline stone in thick beds is quarried for building purposes. It is filled with encrinal and coralline fossils and the unequal weathering of the matrix and the fossiliferous portions are sometimes such as to give the dressed surface a pitted appearance with cavities which roughen and disfigure it. For foundations and heavy masonry it is well adapted. It has been extensively employed in the western part of the state.

Lower Helderberg limestones

The Water-lime, Tentaculite and Pentamerus limestones are included in this group. The outcrops are in the Rondout valley, southwest from Kingston to the Delaware river; in the foothills east of the Catskills—in Ulster and Greene counties; on Becraft's mountain, near Hudson; and in a belt stretching west from the Hudson valley, along the Helderbergs and across Schoharie into Herkimer county.

The Tentaculite limestone is dark-colored, compact and in thick beds and can be quarried in large blocks. Some of it can be polished and makes a beautiful black marble, as for example, that of Schoharie.

The Pentamerus limestones, both the lower and the upper, are in thick beds and are gray, sub-crystalline in texture, and look well when dressed. They are adapted to heavy masonry as well as for cut work.

Quarries are opened in this group of limestones in the Schoharie valley, at Howe's Cave, Cobleskill, Cherry Valley and in Springfield. The quarries west of Catskill and in Becraft's mountain, near Hudson, are also in it.

Upper Helderberg limestones

The Upper Helderberg formation appears in the Hudson valley at Kingston; thence it runs in a belt west of the river, to the Helderberg mountains, bending to the west-northwest, and thence west it continues across the state to the Niagara river and Lake Erie. The subdivisions are known as the Onondaga, the Corniferous and the Seneca limestones. The first is more generally recognized as the 'Onondaga gray limestone' and the last as the Seneca blue limestone.

There is much diversity in the limestones of this group in its long range of outcrop. The Onondaga gray stone is gray in color, coarse crystalline; and makes beautiful ashlar work, either as rock face or as fine tooled, decorative pieces.

The Corniferous limestone is hard and durable, but it is so full of chert that it can only be used for common wall work.

The Seneca blue limestone is easily dressed and is a fairly good building stone.

Limestone of the Upper Helderberg epoch is quarried extensively at Kingston, Ulster county, and is a valuable building stone. In Onondaga county there are the well-known Splitrock and Reservation groups of quarries, which have produced an immense quantity of excellent and beautiful stone and which has found a market in all of the central part of the state. They are in the lower member of the group. Going west, there are the large quarries in the Seneca limestone at Union Springs, Waterloo, Seneca Falls and Auburn. The LeRoy, Williamsville, Buffalo and Black Rock quarries are in the Corniferous limestone.

The aggregate output of the quarries in the Upper Helderberg limestones exceeds in value that of any other limestone formation in the state. The many quarries of the Trenton probably produce more stone.

Tully limestone

The Tully limestone lying above the Hamilton shales, is a thin formation which is seen in Onondaga county and to the west—

disappearing in Ontario county. It does not furnish any stone other than for rough work and in the immediate neighborhood of its outcrops.

Calcareous tufa

As a supplement to the limestones the quarries in calcareous tufa at Mohawk, in the Mohawk valley, and at Mumford, Monroe county, should here be mentioned, although they are only of local importance.

GLACIAL DRIFT

This material, consisting of unsorted clays, sands, gravels, cobbles and boulders, is found in all parts of the state. The nature of the imbedded stone varies greatly both as to variety and amount. In places the deposits are full of large blocks of stone and of more or less rounded and scratched boulders; in other localities the hard, quartzose cobbles and small boulders predominate. In the sandstone districts of the southern and western parts of the state the surface deposits of glacial drift contain much sandstone, as in the Medina sandstone belt, the Hudson river blue stone territory and the red sandstones at Haverstraw and Nyack. In the Highlands and in the Adirondacks the rounded, crystalline, granitoid and gneissic rocks predominate. On Long Island the terminal moraine includes a great amount of stone, and of many kinds.

The cobblestones were formerly used for paving roadways, but this kind of pavement is no longer laid. From the fact of the stone being picked off the fields in the clearing of land for tillage, the stone fragments from the drift have been known as 'field-stone;' and they were used in the earlier constructions for walls, foundations and buildings, in localities where no quarries had been opened.

Some of the oldest houses on the western end of Long Island, and in the Hudson river counties are built of such field stone. At Yonkers the excavations for foundations and in street grading afford an abundant supply of stone for common wall work. In parts of Brooklyn the drift furnishes a great deal of stone in the shape of huge boulders.

The stone of the drift is generally hard and durable, having resisted the wear of rough transportation. The economic use of the surface stones of the drift in constructive work, where they can be laid up in walls, is a desirable utilization of what is still in many parts of the state worse than waste—a nuisance in the tilling of the soil. This formation can not, however, be considered as one of the important sources of stone in the quarry industry, although capable of yielding a great deal of rough stone. It will no doubt do so in the future clearing and improvement of the country.

Road Metal

In New York the best materials for road metal are trap, granite and magnesian limestone.

Trap is a general term for some of the basic eruptive rocks, the word being related to or derived from the German *Treppen* which signifies a flight of steps and is suggested by the somewhat regular manner in which the rock is jointed.

The trap which is used in New York for a road metal is a diabase and consists chiefly of the minerals augite and labradorite, the former being a silicate of iron and magnesia and the latter being a lime-soda feldspar. Other minerals are present in small quantity but do not influence the properties which make the rock valuable as a road metal.

While sufficiently hard to resist the wear of heavy traffic to a satisfactory extent, it possesses a high degree of binding or cementation power. This means that the dust produced by wear when moistened unites quite firmly and forms a cement which binds the larger fragments to a considerable extent.

This property is most noticeable in rocks containing much lime, magnesia and alumina.

Good trap is found only in Richmond and Rockland counties, and in the intermediate area of New Jersey bordering the Hudson river. Its outcrop is known as the ‘Palisades.’

Granite consists chiefly of quartz mixed with one or more of the feldspars and hornblende or a mica. Hornblende has essentially

the same composition as augite which occurs in trap; and a hornblende granite should be a very good road metal. Where hornblende is absent one would expect to find less binding power.

Granite is harder than trap and therefore should resist wear better, but this quality is offset by its usually smaller binding power so that trap should be preferred as a rule.

Granite is found in the Adirondack region and in the Highlands of the Hudson, also in Westchester county. The commercial term granite includes various kinds of gneiss.

Magnesian limestone has great binding power but is quite soft and therefore not very durable for heavy traffic. Chemically, this rock is a carbonate of lime, containing also magnesia, alumina and silica. It has been suggested that it might be used profitably as a binder with stone of less binding power.

Sandstone has usually no lime, magnesia or alumina and therefore has no binding properties and never makes a first rate road, as the fragments continually break loose.

Limestone is found chiefly in areas parallel to and near the main line of the New York Central railroad and in a zone around the Adirondacks.

In New York the best road materials occur in certain limited areas, and at points distant from these the cost of transportation is the controlling feature.

For high class road building, trap and granite will be preferred and used in all places where their cost is not prohibitory. Experience shows, however, that unless these materials are used under the direction of experienced road engineers, they are less satisfactory than limestone, and when it is proposed to macadamize a road by simply covering it with broken stone, the latter though less durable, will be more satisfactory.

When granite and trap are properly laid, on a well prepared bed and rolled with a heavy steam roller to the proper standard of firmness, nothing can be better, but where no steam roller is available and the subgrade is not properly prepared, the trap and granite are liable to afford only an unpleasant and uneven surface of hard angular fragments which ceaselessly roll about on the

surface of the road injuring the horses and making pleasure driving impossible.

Limestone from its softness and greater binding power is more easily rolled into an even surface under the wheels of vehicles, and while not having the durability to support heavy traffic for a long time, can be cheaply renewed if the source of supply is not far distant. This fact has been recognized for a long time at points within easy reach of the limestone quarries. In Onondaga county at many points a portable crusher has been used to crush the blocks for road metal from the limestone fences which are cheerfully donated by the residents for the improvement of the roads. There are many other counties in which this might be done as may be seen from the geologic map. In most of these areas limestone will be found in the fences and may be crushed for road metal at small expense.

Many of the local stone quarries, which are scattered over the state, sell for road metal the rock obtained in stripping off the upper layers from their quarries.

A few large quarries are operated for road metal alone and deserve special mention.

Many tons of material are quarried annually from the Palisades range near Piermont. The material, which is exceedingly tough, is either dressed for paving blocks or crushed for road metal.

Farther up the Hudson river the limestone quarries of Tomkins Cove have been in operation for a number of years and supply large quantities of rock for macadam. Other quarries are at South Bethlehem, Albany county, Howe's Cave, Schoharie county and there are several near Syracuse and Buffalo. This magnesian limestone is one of the best materials used. It is hard, packs easily and makes a good surface, but the cost of maintenance is considerable.

At Iona Island a granite is quarried and crushed to five or six different sizes for road metal and concrete. The fine residue or dust is sold for polishing.

PLATE CIX.—To face page 206.

H. Ries, photo.

LIMESTONE QUARRY, TOMKINS COVE, ROCKLAND CO. METAMORPHOSED CALCIFEROUS-TRENTON LIMESTONE.

PLATE CX.—To face page 206.

H. Ries, photo.

QUARRY IN LOWER HELDERBERG LIMESTONE, SOUTH BETHLEHEM, ALBANY CO.

I. P. Bishop, photo.

ROAD METAL AND PAVING BLOCK QUARRY OF THE BARBER ASPHALT CO., NEAR HUMBOLDT PARKWAY, BUFFALO, ERIE CO. CORNIFEROUS LIMESTONE.

PLATE CXII.—To face page 206.

I. P. Bishop, photo.

STONE CRUSHING PLANT OF THE BARBER ASPHALT CO., BUFFALO, ERIE CO.

The Hudson River Stone Supply Company has an extensive plant for quarrying and crushing granite, at Breakneck Mt, north of Cold Spring. The same company operates a second plant for supplying crushed limestone at Stoneco, north of New Hamburg.

One of the largest quarries in the state is that of P. Callanan at South Bethlehem, Albany county. The Lower Helderberg limestone is the rock used and it makes a good road.

The Cauda galli grit of Albany county is used in small quantities locally and makes an excellent road, though it is not durable.

At Duanesburg, near Schenectady, sandstone of the Hudson river group is crushed for road metal.

At Port Chester, Westchester county, a coarse-grained granite is quarried and is considerably used locally, but the best macadam roads of that district are of limestone from Tomkins Cove.

The gray gneiss has been considerably used as a road material in Westchester county.

On Staten Island the yellow gravel is much used for road making; also the diabase or trap from the Graniteville quarries, which is being extensively used on a system of county roads with the most satisfactory results.

The materials used for making roads in the state vary with the locality. If the traffic on the road is moderate it is generally safe to use the local material, whatever its nature, unless it be shale, but if there is a heavy traffic it will pay in most instances to get a stone of superior quality from elsewhere.

The requisite qualities of a road metal are hardness and toughness. Where both these qualities are not obtainable in the same stone the latter is perhaps preferable.

Silicious rocks, though often hard, do not consolidate as well nor so quickly as limestone, owing to the sandy detritus formed by the former having no cohesion. The detritus of magnesian limestone acts like a mortar.

Granite and gneiss, especially if very micaceous, are apt to disintegrate rapidly and produce dust and mud.

Shale is to be avoided, as it breaks up rapidly, forming a sticky mud.

Gravel, while making a serviceable road, does not pack well, and is not durable. If it has to be used, some of the difficulty may be overcome by cracking the pebbles so as to produce an angular form.

Clay and Clay Products[a]

Deposits of clay occur in nearly every county of New York. They belong to three geological periods, namely:

Quaternary, Tertiary and Cretaceous.

The clays of the first age are by far the most common. Those of the second are somewhat indefinite in extent, but they probably include a large number of the Long Island deposits. Of the third class there are undoubted representatives on Long Island and Staten Island.

The clays of the mainland are all Quaternary so far as known. The problems of Quaternary geology in New York are by no means solved, and it is not always possible to decide on the causes leading to the deposition of any particular body of clay by a single visit to the locality.

A great majority of the deposits are local, lying in the bottoms of valleys which are often broad and fertile. They vary in depth from four to 20 or even 50 feet; as a rule they are underlaid by modified drift or by bed rock. The clay is generally of a blue color, the upper few feet being weathered mostly to red or yellow. Stratification is rarely present, but streaks of marl are common. In some of the beds small pebbles, usually of limestone, are found, and these have to be separated by special machinery in the process of manufacture. In many instances the clay is covered by a foot or more of peat.

These basin deposits are no doubt the sites of former ponds or lakes, formed in many instances by the damming up of valleys, which have been filled later with the sediment of the streams from the retreating ice sheet. The valleys in which

a Abridged from Bulletin No. 12 New York State Museum, by Heinrich Ries.

these deposits lie are usually broad and shallow. The broad flat valley in which the Genesee river flows from Mt Morris to Rochester is a good example. The waters of the river were backed up by the ice for a time, during which the valley was converted into a shallow lake in which a large amount of aluminous mud was deposited. This material has been employed for common brick.

Around Buffalo is an extensive series of flats underlaid by a red clay. A thin layer of sand suitable for tempering overlies the clay in spots, and limestone pebbles are scattered through it. Similar deposits occur at several localities to the north of the Ridge road and around Niagara Falls, also at Tonawanda and La Salle, to the north of Buffalo, as well as south of it along the shore of Lake Erie. No doubt much of this clay was deposited during the former extension of the Great Lakes.

Prof. James Hall mentions deposits of clay at the following localities: at Linden, one mile south of Yates Center; [a]along the shore of Lake Ontario, east of Lewiston; on Cashaqua creek [b]deposits of tenacious clay due to the crumbling of the argillaceous green shales; in Niagara county [c]beds of clay are said to occur in every town, but they often contain a considerable amount of lime.

At Levant, four miles east of Jamestown, Chautauqua county, is an interesting bed of blue clay having an area of several acres. It is probably of post-glacial age.

At Breesport, near Elmira, is a bank of blue clay rising from the valley to a height of 50 feet. It was evidently formed when the valley was dammed up, and has subsequently been much eroded so that all that now remains is a narrow terrace along the side of the valley. A similar deposit is found at Newfield, south of Ithaca. A moraine crosses the valley a mile or two south of it.

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[a] Geology of New York, 4th District, 1843, p. 437.
[b] Ibid., p. 227.
[c] Ibid., p. 444.

In the southern portion of the state we find clays in abundance, in all the valleys, and lowlands. The extensive marshes near Randolph and Conewango are said to be underlaid by clay throughout their entire extent.

A bed of blue and red clay is being worked at Brighton near Rochester. This deposit lies near the head of Irondequoit bay.

Clays are also found at several points in the valley of the Oswego river from Syracuse to Oswego, an important one being at Three Rivers.

Deposits of clay suitable for brick and tile occur extensively in the lowlands bordering the Mohawk river from Rome to Schenectady. The beds vary in thickness from six to 15 feet and are mostly of a red, blue or gray color.

An extensive bed of red and gray clay, 20 acres in extent and horizontally stratified, occurs at Watertown. The deposit is 20 feet thick and rests on Trenton limestone.

Another deposit of considerable size is being worked at Ogdensburg. The clay is blue and has a depth of 60 feet.

HUDSON VALLEY

Among the most extensive and important clay formations occurring in New York are those of the Hudson valley. These deposits indicate a period of depression, and deposition in quiet water. The clay is chiefly blue, but where the overlying sand is wanting or is of slight thickness, it is weathered to yellow, this weathering often extending to a depth of 15 feet below the surface, and to a still greater depth along the line of fissures. The depth of oxidation is of course influenced by the nature of the clay; the upper portion weathering easily on account of its more sandy nature and hence looser texture. Horizontal stratification is usually present, and the layers of clay are separated by extremely thin laminæ of sand. At some localities the layers of the clay are very thin and alternate with equally thin layers of sandy clay. This condition is found at Haverstraw, Croton, Dutchess Junction, Stony Point, Fishkill, Cornwall, New Windsor, Catskill and Port Ewen. At all of the above-mentioned localities except

PLATE CXIII.—To face page 210.

H. Ries, photo.

PLEISTOCENE BRICK CLAYS, HAVERSTRAW, ROCKLAND CO.

the last two, the clay is overlaid by the delta deposits of rivers tributary to the Hudson, and the alternation of layers may be due to variations in the flow of the rivers emptying at those points, the sandy layers being deposited during periods of floods. Isolated ice-scratched bowlders are not uncommonly found in the clay.

There is often a sharp line of division between the yellow weathered portion and the blue or unweathered part of the clay. The line of separation between the clay and overlying sand is also quite distinct in most cases. Of the blue and the yellow clay the former is the more plastic, but both effervesce readily with acid, due to the presence of 3 to 6% of carbonate of lime, and are, therefore, properly speaking, marly clays. The clay is underlaid by a bed of gravel, sand, hardpan, bowlder, till or bed rock. From Albany to Catskill the underlying material is a dark gray or black sand with pebbles of shale and quartz. The sand grains are chiefly of pulverized shale, the rest being silicious and calcareous with a few grains of feldspar and garnet. This sand can often be used for tempering, but at Catskill contains too much lime for this purpose.

From Catskill northward the clay is in most cases covered by but a foot or two of loam. South of Catskill the character of the overlying material varies.

THE CLAYS OF THE CHAMPLAIN VALLEY

The clays of the Champlain valley are estuary formations and of the same age as the Hudson river clays. They underlie terraces along the lake which have been elevated to a height of 400 feet above the lake surface. These terraces may be traced almost continuously from Whitehall, at the head of Lake Champlain, to the northern end of the lake and beyond it, but on account of the extensive erosion which has taken place, they are usually narrow, and it is only at sheltered points, like Port Kent and Beauport, that they are especially prominent. The section involved is yellowish brown sand, yellowish brown clay and stiff blue clay, the latter being rather calcareous. The upper clay is somewhat

silicious, and its coloring is due to the weathering of the lower layer. This formation has a thickness of about 15 feet, but sometimes, as at Burlington, it reaches a thickness of 100 feet. Isolated bowlders are occasionally found in the clays. The clays are usually horizontally stratified, and contortions of the layers are extremely rare. Numerous marine Quaternary fossils have been found in the overlying sands; the skeleton of a whale has also been found in them.

Openings have been made in these deposits for the purpose of obtaining brick clays at Plattsburg and a few other localities.

LONG ISLAND CLAYS

Clay beds are exposed along the north shore of the island and at several points along the main line of the Long Island railroad.

There is still some doubt as to the exact conditions under which the beds of clay and gravel which form the greater portion of Long Island were deposited, but it is probable that the clays represent shallow water marine deposits of Cretaceous and Tertiary age.

The age of the clays is still largely a matter of speculation, and will probably remain so in many cases unless palaeontologic evidence is forthcoming. Those on Gardiner's Island are quite recent, as shown by the contained fossils, and the clay on Little Neck, near Northport, is Cretaceous. The age of the Glen Cove clay is probably Cretaceous.

Cretaceous leaves in fragments of ferruginous sandstone have been found along the north shore of Long Island from Great Neck to Montauk Point,[a] but they are usually much worn and scratched and have evidently been transported from some distant source. The clays at Center Island, West Neck, Fresh Pond and Fisher Island are very similar and are very probably of the same age, possibly Tertiary, but we lack palaeontologic or stratigraphic evidence. At West Neck the clay underlies the *yellow gravel,* and the latter is covered by the drift, so that is Prepleistocene.

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[a] Hollick, *Notes on Geology of the North Shore of Long Island*, Trans. N. Y. Acad. Sci., XIII.

STATEN ISLAND CLAYS

The clays of Staten Island are chiefly Cretaceous, as proven by the fossils found in them. The chief outcrops are at Kreischerville, Green Ridge and Arrochar. Besides the clay there are several 'kaolin' deposits.

These clays are used in the manufacture of drain tile, terra cotta, etc.

CLAY PRODUCTS

The increasing value of clay for the manufacture of brick, tile, terra cotta, pottery, etc., and the ever growing demand for these products have given rise to an industry which is rapidly assuming vast proportions, and will, in the near future, become one of the most extensive and important in the country. Scattered over New York are extensive deposits of clay, many of them capable of being used for the manufacture of terra cotta, roofing tile and the coarser grades of pottery. To add to their value the most extensive beds of clay are situated in close proximity to the waterways and railroads which lead to the principal cities of the state. The commoner kinds of clay products, such as building brick, are marketed within the state, but the higher grades, such as terra cotta and roofing tile, have found good markets outside of New York.

At present bricks are the chief source of income. That the other branches of the clay industry are not further advanced is probably due in a large measure to the fact that the clay deposits of the state have been so little exploited or otherwise examined. Though many of the deposits have been opened up and are still being worked, there are numerous others scattered over the state which are still untouched. Few of the clays are found to be of sufficiently refractory character to be used for making fire brick, gas retorts, or other products which in use are subjected to a higher degree of heat; but for the manufacture of coarse pottery, terra cotta, paving brick, etc., many of the clays are eminently suited.

Shales and Shale Products

Within the last seven or eight years the manufacturers in New York have turned their attention toward the extensive beds of argillaceous shale which the state contains, and which on trial have given very satisfactory results. Several large firms are using them for the manufacture of sewer pipe, terra cotta, paving brick and roofing tile. The shale formations at present used are the Salina, Hamilton and Chemung. The Hudson river shales are no doubt sufficiently argillaceous over many areas to be used for the manufacture of clay products, and the same may be said of the Niagara shale, which weathers to a clay.

Iron Ores

The iron ores of New York have been carefully studied and described by Prof. J. C. Smock, who has published his results in Bulletin No. 7[a] of the New York State Museum and by Mr. Bayard F. Putnam, who contributed an article on this subject to the volume on Mining Industries (No. XV) in the report of the tenth census. These two important papers, taken together give a most complete review of the sources of iron in New York. Our knowledge of the Adirondack ores is supplemented by the work of Prof. J. F. Kemp, which is contained in Bulletin No. 13 of the New York State Museum, entitled the Geology of Moriah and Westport townships. The localities of all the principal mines are shown on the economic map.

Iron in its native or metallic form is not known to exist within the state of New York, nor is it at present anywhere a commercial source of the metal. We are therefore chiefly dependent upon the combinations of iron with oxygen for our supply of that indispensable substance.

The ores of iron, which occur in beds and deposits of workable size in the state of New York, may be classified by their chemical composition, into oxides and carbonates of iron, and these may be subdivided, following the mineralogical characters, into

[a] The following description is abridged with some alterations and additions from Bulletin No. 7.

species and varieties. The following tabular arrangement shows the natural grouping of the species:

	Chemical name	Mineralogical species and common names
Oxides	Ferric and ferrous oxides. Proto-sesquioxide of iron. 72.4 % of iron.	Magnetite. Magnetic iron ore. Titaniferous iron ore.
	Anhydrous ferric oxide. Sesquioxide of iron. 70 % of iron.	Hematite. Red hematite. Specular ore. Clinton ore.—Fossil ore. Red ochre.
	Hydrated ferric oxide. Sesquioxide of iron. 60 % of iron.	Limonite. Brown hematite. Brown ochre. Bog iron ore.
Carbonates	Ferrous carbonate. Carbonate of iron. Spathic 48 % of iron. Iron ore	Siderite. Carbonate ore. Clay iron stone. 'White Horse.'

A general law of occurrence of iron ores is that certain species occur in, or are characteristic of, definite geological horizons. For example, the magnetic iron ores and the red hematite are found in the crystalline rock areas of the Pre-cambrian; the fossil ore, the limonite or brown hematite and the carbonate are found in the Palaeozoic rocks; and the bog iron ore in the more recent formations of Tertiary and Post Tertiary ages. There are, as might be expected, many exceptions; but in the greater number of these apparently exceptional cases, the surface alteration, due to weathering or other atmospheric agencies, explains the occurrence.

This relation between the geological formation and the mineralogical species or *kinds* of iron ore indicates the areas in which they may occur, and determines roughly their limits. Hence, a geological map of the state shows approximately correct boundaries of the several iron-ore districts, and is, as it were, an iron

mines map. The geology of a county or district gives the clue in searching for ore; and its importance can not be too strongly stated, both as a guide, suggesting exploration, and warning against unnecessary and fruitless surveys and wasteful outlays of time and money. For example, the magnetites belong to the crystalline rock districts, and the search for them in the later, sedimentary rocks of the adjacent territory would be a hopeless task; or, again, the exploration of the Highlands or Adirondacks, for carbonate ores, would be equally unscientific and destitute of good results.

The geological formations, which are characterized as definite ore horizons, become the basis of a natural arrangement of the ore districts of the state. They are well marked geographically also.

Following this geologico-geographical arrangement, the groups and iron-ore districts are:

1 The Highlands of the Hudson.—Magnetic iron ores.

2 The Adirondack region, including the lake Champlain mines.—Magnetic iron ores.

3 The hematites of Jefferson and St Lawrence counties.

4 The Clinton or fossil ores.

5 The limonites of Dutchess and Columbia counties.

6 The limonites of Staten Island.

7 The carbonate ores of the Hudson river.

A few isolated mines can not be thus classified, as the hematite near Canterbury, Orange county, Ackerman's mine near Unionville, Westchester county, the Napanoch and Wawarsing mines, in Ulster county, the hematite of Mt Defiance in Ticonderoga, and the bog iron ores which are scattered in all of the great divisions of the state. The iron sands of the shores of Long Island are left out, as not properly a natural source of iron.

MAGNETIC IRON ORES

The Highlands of the Hudson

Magnetite is one of the common minerals in the crystalline rock region of the Highlands. It occurs as an accessory constituent in the granitic and gneissic strata; and by itself, forms

beds of considerable extent and thickness. Accordingly as it is more or less free from foreign minerals it is rich or lean, varying from the pure magnetic iron ore which contains 72.4% of iron to rock containing only traces of iron in its mineralogical composition. The beds of ore show lamination and are faulted, folded and contorted as the inclosing strata of rock, and have the same general strike and dip in common with the latter. They are generally of irregular form, in places widening into thick deposits or lenticular shaped masses, in others contracted in thin sheets, which are not mined profitably. The ore is found in some cases to separate into thin layers, and masses of rock ('horses') are met with entirely surrounded by the ore. The phases of variation are almost as many as there are mines, where they can be studied. In the larger and older mines the ore has been followed for thousands of feet in the line of strike or on the course of the ore, and for hundreds of feet in depth (on the line of dip) without reaching its limits. Owing to the unprofitable nature of working such thin ore beds, they are often not followed to the end, and the real extent of few of these ore deposits is known. In general, it may be stated that in this region the ore beds stand nearly on edge and have a northeast and southwest strike and a descent or dip at a steep angle to the southeast. In consequence of their highly inclined position and their irregular shape these ore bodies are called 'veins,' less frequently 'chimneys' and 'shoots' of ore.

The magnetic iron ore has not been found distributed uniformly throughout the Highlands. There appear to be certain ore *ranges* or belts in which the larger and more productive mines are opened. There are mine groups also, as the Sterling Iron and Railway Company's mines, the Greenwood mines, in Orange county; the Todd-Croft and Sunk mines, and the Croton-Brewster ranges in Putnam county. The boundaries of these ore-bearing belts and the intermediate barren territory have not been determined, since the exploration has been largely made by individual effort and without any general plan covering the whole area.

Mines have been opened in Orange, Rockland, Westchester

and Putnam counties in this iron ore district and from the New Jersey line at the southwest to the Connecticut boundary on the east. Some of the largest and most productive mines in Orange county have been worked more than a century.[a] This county was famous for its iron manufacture during the revolutionary war.[b] The greatest development of the iron mines in Putnam county has been since the opening of the Tilly Foster and Mahopac mines or during the last 25 years. The distance from public lines of transportation, the increased cost of working the smaller 'veins' at greater depths, the low prices for iron ore and the competition with the richer ores of other parts of our country have necessitated the suspension of work in some of the mines and led to the permanent abandonment of those most unfavorably situated. The ores of the Highlands district are the hard, crystalline magnetites. They are generally rich, free from titanium, but contain a slight excess of phosphorus above the limit for the manufacture of Bessemer iron, excepting the Mahopac and Tilly Foster mines, which have yielded a large amount of Bessemer ore, and a few small mines, but which are no longer worked.

The Adirondack Region, Including the Lake Champlain Mines

The Adirondack region, the great mountain plateau of northern New York, is bounded by the valleys of Lake Champlain on the east, of the St Lawrence river on the north and northwest, of Black river on the west, and the Mohawk on the south.

Magnetite is one of the common minerals in the Adirondacks, and is widely distributed, both as a constituent or accessory mineral in rocks, and in beds of workable extent. Mines have been opened in all parts of the region, but the greatest development has been in the valley of Lake Champlain, and hence the ores are known in the market as Lake Champlain ores.

The beginnings of iron-ore mining in the Lake Champlain valley were early in the present century. Some of the forges were

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a Ore was discovered on the Sterling tract as early as 1750; the Forest of Dean mine was opened about the same time.

b See *History of the Manufacture of Iron in all Ages*, by James M. Swank, Philadelphia, 1884, pp. 102-106.

in operation in 1801 and 1802, and they were run upon the ores in their vicinity. But the output was small, in the aggregate a few thousands of tons. The rapid increase was after 1840.

THE HEMATITE ORES OF ST LAWRENCE AND JEFFERSON COUNTIES

The hematites, or red hematites, as distinguished from the brown hematites (limonites) are mined in a narrow belt, scarcely 30 miles long, stretching from Philadelphia, in Jefferson county, northeast into Hermon, in St Lawrence county. The ore deposits are found associated with a so-called *serpentine* rock, and lying between the Potsdam sandstone and the crystalline rocks of the Archaean age.

The hematite of these mines is generally firm and massive, of a deep red color, soiling whatever it touches. In some of the mines there is a specular ore, which has a crystalline structure, metallic lustre and is of a steel-gray to black color. Calcite, carbonate of iron, ferruginous quartz, pyrite and millerite occur in the ore. These ores average from 48 to 53% of metallic iron. They contain an excess of phosphorus above the limit demanded by furnace managers for making Bessemer iron. For mixing with more refractory ores they are sought after, being almost self-fluxing. In the market they are often known as 'Antwerp red hematites' and 'Rossie hematites.'

Charcoal furnaces were built early in this century at Rossie, St Lawrence county, and at Sterlingville and Antwerp, in Jefferson county, for smelting these ores.

THE CLINTON OR FOSSIL ORES

The red hematite of the Clinton group bears several names; from its aggregated grains it is termed 'oolitic ore' or 'lenticular iron ore;' from its fossiliferous character, it is widely known as 'fossil ore,' and from its place in the geological series, it is often called 'Clinton ore.' It is remarkable for the thin, yet persistent beds over wide areas, which lie between green shales and calcareous strata. Following the outcrop of the Clinton group, the ore has been found in Herkimer, Oneida, Madison,

Cayuga, Wayne, and Monroe counties. West of the Genesee river Prof. Hall reports that it was not seen.[a] There are two beds, generally about 20 feet apart, according to Vanuxem's report on the Clinton group, thin, averaging little more than a foot, and distinguished by more abundant oolitic particles in the lower bed and by the larger grains and concretions in the upper bed.[b] Very little mining has been done, excepting in the towns of Clinton, Oneida county, and Ontario, in Wayne county. The average thickness of the beds in these mines is 30 inches, and one bed only is worked. They lie almost horizontal, dipping slightly to the south; and in the extraction of the ore a part of the overlying shales has to be removed and the roof supported by timbering.

The ore consists of lenticular-shaped grains, closely aggregated in a firm solid mass, which has to be broken up by blasting and heavy sledging. It is more friable and soft on the outcrop. It is brownish red in color and soils like a paint. The percentage of metallic iron varies less than in the magnetic iron ores and in the brown hematites. The average is 44 to 48%. The phosphorus is above the Bessemer limit. It is well adapted for making foundry iron and is used for that class of iron mainly. Local furnaces take nearly all the output of the mines. The first lease for digging Clinton ore was given in 1797.[c]

THE LIMONITES OF DUTCHESS AND COLUMBIA COUNTIES

The ore deposits and mines, as here grouped, are in two principal ranges and limestone valleys. First, the Fishkill-Clove belt, stretching northeast, from the Highlands of the Hudson, across the towns of Fishkill, East Fishkill, Beekman and Unionvale; second, the north-south valley, traversed by the New York and Harlem railway, from the Highlands across Dutchess county, and to Hillsdale in Columbia county. The limonite, or brown hematite ore, is found in small pockets of irregular shape, and

a Hall Report on *Survey of the Fourth Geological District*, Albany, 1843, p. 61.
b Vanuxem Report on *Survey of the Third Geological District*, Albany, 1842, p. 83.
c BIRKINBINE; *The iron ores east of the Mississippi River*, in Mineral Resources of the United States for the calendar year 1886, p. 60.

also in large deposits, which are associated with ochreous clays, and in some cases, with a gray carbonate of iron, in beds underlying it. These ore bodies are wholly in the limestone or between the limestone and the adjacent slate or schist formations, or they are in the latter, and as a rule of occurrence they are found on or near the dividing line between these formations. Near Fishkill and at Shenandoah the deposits are at the border of the Cambrian sandstone and at the foot of the Archaean ridges. The existence of the carbonate ore in the deeper parts of some of the mines and interstratified with the limestones is suggestive of the origin of the oxide (limonite) by the decomposition of the ferriferous beds through oxidation and the agency of carbonated waters, and of the great masses of colored clays, also, through the disintegration and decay of the slaty rocks and more argillaceous limestone. The limestone of these valleys and the overlying slaty rocks have been studied by Prof. Dana, and are referred by him to the Trenton limestone and the Hudson river slate formations.

The ore occurs, (1) in large masses, somewhat cellular, having the interstices filled with clays or sandy earths, (2) in cavernous and hollow 'bombs' often with beautiful mammillary or stalactitic incrustations on the interior, and, (3) in irregularly shaped, fragmentary masses, distributed unevenly through the ochreous clays ('ochres') and sandy earths.

The earliest iron manufacture in the state was in Columbia county, on Ancram creek, and was probably on these ores.

THE LIMONITES OF STATEN ISLAND

The group of iron mines on Staten Island is in a superficial deposit probably derived from the underlying rock in the process of decomposition which has produced the serpentine of that region.

THE CARBONATE ORES OF THE HUDSON RIVER

The mines of spathic iron ore, or carbonate ore, are in the valley of the Hudson river, in Columbia county, south of the city of Hudson, and in Ulster county near Napanoch. The mines

south of Hudson are known as the Burden iron mines; and, on account of their extent and productiveness, and the comparative insignificance of the Ulster county mines, they may be considered as practically the whole of this group. The range in which the Burden mines are opened is between one and two and a-half miles east of the river, opposite Catskill, and is four miles in length, from north to south. It lies partly in the town of Greenport and partly in Livingston. The ore crops out in the western face and near the crest of Plass Hill at the north, and in Cedar Hill and Mount Thomas at the south. It is stratified, and its bed dips at angles of 20° to 40° to the east.

The first mining of considerable extent done on this range was in 1874.

LIME AND CEMENT.

Lime is produced throughout the State on the outcrops of the Calciferous, Trenton, Niagara and Helderberg limestones. Some of the chief localities are Glens Falls, Howe's Cave, Rochester, Buffalo, Sing Sing, Pleasantville and Tuckahoe. Hydraulic cement or water lime is chiefly produced from beds of hydraulic limestone in the Water lime group at the base of the Lower Helderberg. Rondout and Rosendale, Howe's Cave and the vicinity of Syracuse are important commercially for this product. At Akron and Buffalo much water lime is made, but from a lower formation, probably the Salina Group.

Portland cement is made from marl and clay at Warner's near Syracuse, and at Wayland, Steuben county; from lime and clay near Glens Falls and at other points.

LIMESTONE FOR FLUX.

In the present depressed condition of the manufacture of iron in New York, the production of limestone for flux is but a small industry.

Mineral Paint

The mineral paint of New York state is from comparatively few localities, and is manufactured from rocks of five formations:

1 From Rossie iron ore.

2 From Cambrian red and green slate, near Whitehall.

PLATE CXIV.—To face page 222.

N. H. Darton, photo.

QUARRY IN TRENTON LIMESTONE, SARATOGA CO., SOUTH BANK OF HUDSON RIVER OPPOSITE GLENS FALLS. ROCK QUARRIED FOR QUICK-LIME.

PLATE CXV.—To face page 222.

H. Ries, photo.

INTERIOR VIEW OF CEMENT MINE AT ROSENDALE, ULSTER CO. WATERLIME GROUP.

PLATE CXVI.—To face page 222.

N. H. Darton, photo.

CEMENT QUARRIES, ONE MILE SOUTH OF WHITEPORT, ULSTER CO. WATERLIME GROUP.

PLATE CXVII.—To face page 222.

N. H. Darton, photo.

QUARRY IN LOWER PENTAMERUS AND TENTACULITE LIMESTONE, HOWE'S CAVE, SCHOHARIE CO.

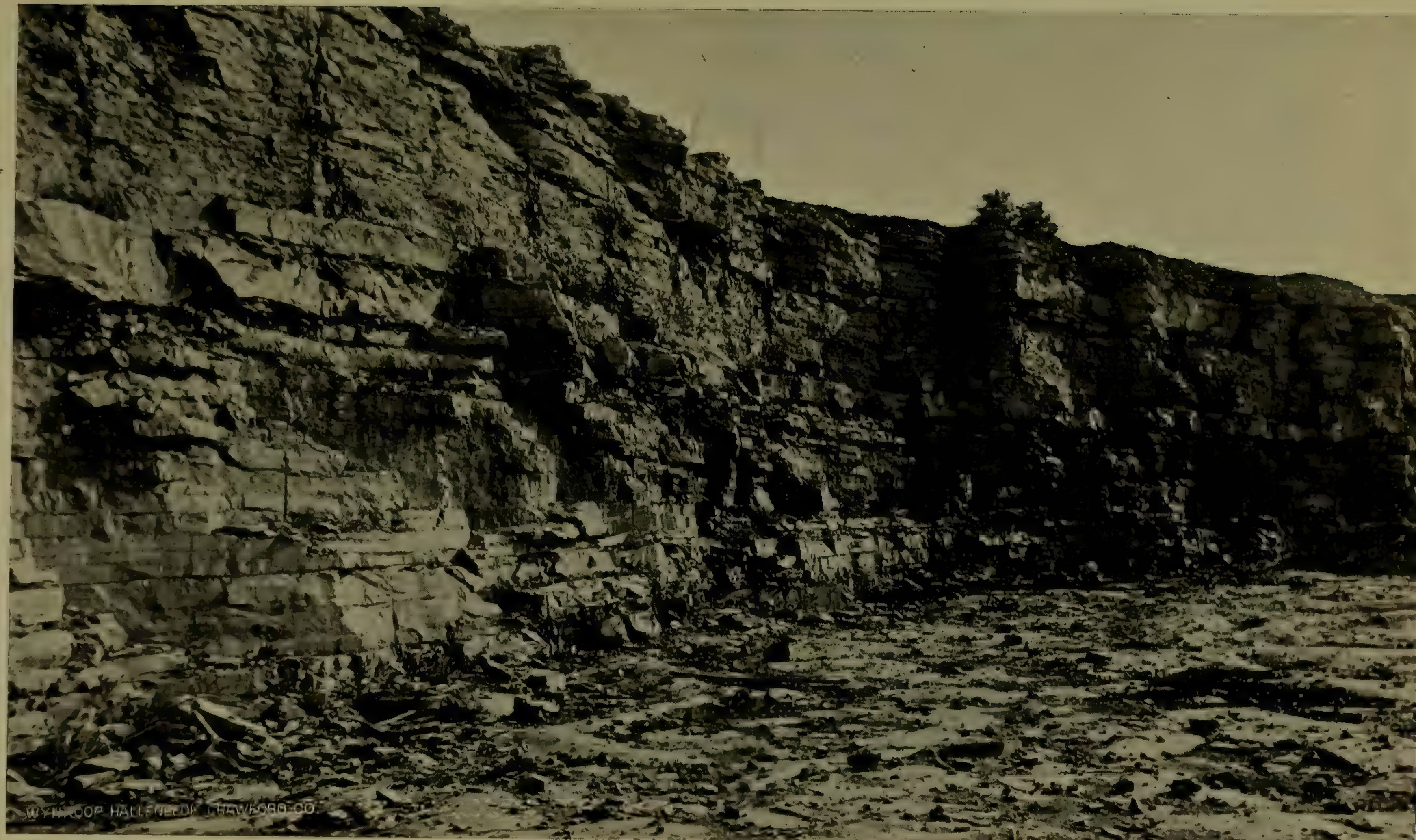
PLATE CXVIII.—To face page 222.

Corniferous limestone.

Onondaga limestone.

Impure cement rock.

Beds from which cement is made.



I. P. Bishop, photo.

QUARRY OF THE BUFFALO CEMENT CO., BUFFALO, ERIE CO.

I. P. Bishop, photo.

QUARRIES OF THE BUFFALO CEMENT CO., BUFFALO, ERIE CO. RAILWAY FOR DRAWING STONE TO THE CRUSHER.

3 From Clinton iron ore.

4 From Chemung shale, at Randolph.

5 From Catskill shale at Roxbury and Oneonta.

This material is produced as a by-product in several industries. For instance near Whitehall red and green mineral paint are produced by grinding up the refuse of the slate mills. At Clinton, Oneida county, paint is manufactured from the Clinton iron ore. At Randolph in Cattaraugus county, paint is made from red shales of the Chemung group. At Roxbury, Delaware county, paint is made from red Catskill shales and at Oneonta a similar pigment has been made.

Marl

This material is found in many places throughout the state. Dutchess, Columbia, Orange, Ulster, Greene and Albany counties have many small deposits; in central and western New York there are large deposits in Onondaga and Madison counties, particularly in the Cowaselon swamp; it is also found in Cayuga, Wayne, Seneca, Ontario, Monroe, Genesee and Niagara counties.

It is a deposit formed in standing water and consists chiefly of carbonate of lime. It is largely used as a fertilizer, but is also employed in the manufacture of Portland cement as at Warners, Onondaga county, by the Empire Portland Cement Co., at Montezuma and at Wayland, Steuben county, by Millen & Co.

Millstones

Millstones for grinding paint, feed, cement and other purposes are quarried from the Oneida conglomerate in Ulster county in the town of Rochester at Accord, Granite and Kyserike and in Wawarsing at Kerhonkson.

Salt

The salt industry of New York is of great importance. Originally Syracuse was the center of this industry, but since the discovery of rock salt in and near the Genesee valley where richer brines can be obtained than at Syracuse, the center of the industry

has been transferred to this new district and the manufacture of salt at Syracuse has gradually diminished.

The salt mines of the Retsof, Livonia and Greigsville companies produce immense quantities of salt for the beef and pork packing industries, and in this respect are not directly competitors of the companies manufacturing salt from brine. About 15 miles south of Syracuse the Solvay Process Company having found rock salt in great quantity, by boring a large number of wells and availing itself of an abundant water supply is, by the aid of gravity, enabled to bring brine in a highly saturated condition to its works at Syracuse through a pipe line. This is the basis of a very large industry in soda ash. The Solvay Company also sells brine for the manufacture of salt.

In the Genesee valley and near Warsaw and Wyoming are many salt wells. There are others at Ithaca and Watkins.

A detailed description of the salt and gypsum deposits of New York is given in Bulletin No. 11 of the New York State Museum.

Gypsum

Gypsum is quarried in New York on the outcrop of the Salina group in Madison, Onondaga, Cayuga, Ontario, Monroe and Genesee counties. It is chiefly used as a fertilizer in the form of land plaster, though at Oakfield, Genesee county, a factory has been established to utilize the gypsum in the manufacture of wall plaster.

Graphite

Graphite of excellent quality is obtained near Ticonderoga, the deposit being controlled by the Dixon Crucible Company of Jersey City. The mineral occurs in a mica schist and in crystalline limestone. It is used in the manufacture of pencils, crucibles, lubricants and for a variety of other purposes.

Quartz

This material is quarried for pottery at Bedford, Westchester county, and is shipped to Trenton, N. J. White quartzite of

Cambrian age, quarried at Fort Ann in Washington county, has been ground for use as a wood filler. It has also been used at the Troy Iron Works for lining Bessemer converters and for similar refractory purposes. A similar rock is quarried for wood filler at Billings, Dutchess county.

At Ellenville, Ulster county, quarries and mills are operated by the Crystal Sand Manufacturing Company. The product which is called 'glass sand' is obtained from the Shawangunk grit, which is crushed very fine. Much of it is sent to the glass works at Corning.

Glass Sand

Large glass sand deposits of Quaternary age occur at Durhamville, near Oneida lake. They are operated by William Williams. The sand is not as white nor as fine as that from Ellenville, and is used for the commoner grades of glassware. Much of it is shipped to Lockport. The sand contains 97–97.5% Si. O2.

Glass was formerly made at Sand Lake in Rensselaer County.

An artificial glass sand made at Ellenville is described under the previous head.

Molding Sand

Sand for molding is found in southern Albany county, near the Hudson river, immediately below the surface soil. When this is removed the sand is skimmed off to a depth of about six inches. It is quite extensively shipped from the town of Bethlehem. This is a Quaternary deposit. Near Poughkeepsie molding sand is obtained from a silicious Potsdam limestone, which, in decomposing, leaves a fine sand which has been found very satisfactory for this purpose.

Garnet

Garnet is mined or quarried in New York state in and near the valley of the upper Hudson river in Warren county on the borders of the Adirondack region. It all appears to be of the common variety, Almandite, and occurs in a formation of crystalline limestone which appears to form the bed-rock of the valley in the vicinity of North Creek and Minerva and in gneissic

rocks which adjoin, or are intercalated with, the crystalline limestone. It is found in segregated masses of varying sizes from that of a pigeon's egg to a diameter of 20 feet. It is commercially classified as massive garnet, shell garnet and pocket garnet, the former being impure from the admixture of other minerals. The shell garnet is almost entirely pure and the most valuable for industrial purposes. The pocket garnet is that which occurs in small segregations or incipient crystals in the gneiss.

This garnet is used almost exclusively in the manufacture of sandpaper, or garnet-paper, as it is called, which is employed extensively for abrasive purposes in the manufacture of boots and shoes. It is also employed to some extent in the wood manufacturing industry. For metals garnet is not as good as emery, although some satisfactory results have been obtained from its use on brass. It has been experimentally mixed with emery in the manufacture of emery-wheels but without very satisfactory results.

Emery

The variety of Corundum known as emery is quarried at many points in Cortlandt township, Westchester county, from deposits which occur in the eruptive rocks known as the 'Cortlandt series.' It is used by the New York Emery Company at Peekskill.

Diatomaceous Earth — Infusorial Earth

This material consists of hydrated silica, and is the accumulation of the minute skeletons of microscopic forms of vegetable life known as diatoms. It accumulates in the bottom of ponds and lakes, and is found in recent as well as Tertiary and Cretaceous formations. While the living diatoms are found in all the waters of the state, deposits of diatomaceous earth have been reported from only two localities. One of these is in White lake, town of Wilmurt, Herkimer county, and the other is on the shore of Cold Spring Harbor, Long Island, on the property of Dr. Oliver Jones. The latter is a fossil deposit in beds probably of Tertiary age. The White lake deposit is the only one in use

commercially at present. The material is dug from the bottom of the lake, which covers about four acres, and has a thickness of two to 30 feet, being covered by about four feet of water. It is washed and run through strainers and pipes to settling vats, where it stands for 24 hours. The water is then drawn off and the material shovelled into the press. Here it is made into cakes four feet square and four inches thick. These are subdivided into cakes one foot square and piled under sheds to dry. For this information I am indebted to the proprietor, Mr. Thomas W. Grosvenor, of Herkimer.

The White lake material is at present only used for polishing, though similar material is used for absorbing nitroglycerine in the manufacture of dynamite.

Talc

This material occurs near Edwards, St Lawrence county, N. Y., in a narrow belt several miles long and about a mile wide. There are several quarries on the line of this belt. It is ground in mills near Gouverneur under the control of the Asbestos Pulp Company. It is chiefly used in the manufacture of paper and a small quantity is used in soap, paint and other minor purposes. The annual product is about 30,000 tons, valued at about $240,000.

Peat

This material, which is the residue from the partial decay of plants in water, is of frequent occurrence, but is only used locally as a fertilizer.

Petroleum and Illuminating Gas

The occurrence of petroleum in New York was first recorded by a Franciscan friar who visited the oil spring at Cuba, Allegany county, in 1627. Late in the present century the oil from this spring was highly valued by the Indians for external applications and was thought to have a highly curative power. It was widely known under the name of 'Seneca oil.' The production of oil in New York is at present confined to Cattaraugus

and Allegany counties. The Cattaraugus county field is a northward extension of the Bradford field of Pennsylvania and is continuous over the state line. The Allegany county field is more isolated, although the oil comes from the same geological horizon, which is a sandstone in the upper Chemung or Catskill. This has been discussed in great detail by Charles A. Ashburner in the Transactions of American Institute of Mining Engineers for 1887.

Natural illuminating gas was first used in New York at Fredonia, Chautauqua county, in 1821. It is still in use at the locality in question, but the quantity is insufficient to supply the whole village. Besides Fredonia, at the present time Buffalo, Honeoye Falls, Pulaski and Sandy Creek are using natural gas for heating and illuminating purposes and wells have been bored in the vicinity of Oswego, as well as at Fulton and Baldwinsville. Gas wells have been bored tentatively at a large number of places in New York State and small quantities of gas have been found, but the enterprises have not been financially successful. At present many of the wells in Buffalo have ceased to yield and a large quantity of the natural gas now consumed in that city is brought in pipe-lines from Canada. The gas of Fredonia comes from shales immediately over the corniferous limestone. The gas of the oil districts comes, like the oil, from the horizon of the Catskill. The gas of central and northern New York comes from the Trenton limestone.

Natural Carbonic Acid Gas

This material is obtained at Saratoga Springs and vicinity by boring wells to a depth of about 350 feet. Carbonated waters flow to the surface and are conducted through pipes to large gas holders, where the gas separates from the water and is then pumped into compressors from which it is forced into steel cylinders under a pressure of about 1,000 pounds to the square inch. These cylinders, when filled, are shipped to the consumers, who use it chiefly in the manufacture of soda water, both for the wholesale and retail trades. At present this gas is shipped from

Saratoga Springs to New York. New Jersey, Pennsylvania, Massachusetts, Connecticut and Rhode Island. In addition to the large quantities consumed for soda water, it is also being used for refrigerating purposes and in the manufacture of cod liver oil.

Mineral Waters

The mineral springs of New York are widely known. In addition to the revenue from mineral springs used for baths at health resorts, a large industry now exists in the bottling and shipment of mineral waters for domestic consumption.

List of Mineral Springs in New York which are Commercially Productive

Adirondack Mineral Springs (H. V. Knight), Whitehall, Washington county.

Avon Sulphur Springs (O. D. Phelps), Avon, Livingston county.

Artesian Lithia Spring (C. O. McCreedy), Ballston Spa, Saratoga county.

Cairo White Sulphur Spring (H. K. Lyon), Cairo, Greene county.

Cayuga Mineral Spring (Lucius Baldwin), Cayuga, Cayuga county.

Chittenango White Sulphur Springs (W. H. Young), Chittenango, Madison county.

Chlorine Springs (J. L. Grover), Syracuse, Onondaga county.

Clifton Springs (Dr. Henry Foster), Clifton Springs, Ontario county.

Dansville Springs (J. Arthur Jackson, secretary and manager), Dansville, Livingston county.

Deep Rock Spring (Deep Rock Spring Co.), Oswego, Oswego county.

Massena Springs (Shedden & Stearns), Massena, St. Lawrence county.

Nunda Mineral Springs (Daniel Price), Nunda, Livingston county.

Reid's Mineral Spring (J. R. McNeil), South Argyle, Washington county.

Richfield Springs (T. R. Proctor), Richfield Springs, Otsego county.

Champion Spring (J. Z. Formel), Saratoga Springs, Saratoga county.

Empire Spring (H. W. Hayes, manager), Saratoga Springs, Saratoga county.

Excelsior Spring (F. W. Lawrence), Saratoga Springs, Saratoga county.

Geyser Springs (Geyser Spring Co.), Saratoga Springs, Saratoga county.

Hathorn Spring (Hathorn Spring Co.), Saratoga Springs, Saratoga county.

Old Red Spring (E. H. Peters, superintendent), Saratoga Springs, Saratoga county.

Vichy Springs (L. A. James, superintendent), Saratoga Springs, Saratoga county.

Sharon Springs (John H. Gardner & Son), Sharon Springs, Schoharie county.

Slaterville Magnetic Springs (W. J. Carns & Son), Slaterville, Tompkins county.

Verona Mineral Springs (A. A. Hunt, M. D.), Verona, Oneida county.

White Sulphur Springs (T. C. Luther), Ballston Spa, Saratoga county.

White Sulphur Springs (J. Hochstatter), Berne, Albany county.

Star Springs, Saratoga Springs.

Elkhorn Spring (Clark Snook), Manlius.

Royal Spring (A. Putnam, Jr., president), Saratoga Springs, Saratoga county.

Lebanon Thermal Spring (P. Carpenter), Lebanon Springs.

Crystal Rock Water Co. (L. G. Deland, president), Fairport.

Victor Spring (H. J. Dickinson, Buffalo), Darien, Genesee county.

Geneva Magnetic Mineral Spring (C. A. Steele), Geneva, N. Y., Ontario county.

Oneita Springs (Oneita Spring Co.), Utica, N. Y., Oneida county.

Empire Seneca Spring (M. W. Cobb, of Fredonia), Dunkirk, N. Y., Chautauqua county.

Crystal Spring (Asa D. Baker), Barrington, N. Y., Yates county.

Great Bear Spring, Fulton, Oswego county.

Minerals Not Commercially Important

In addition to the minerals which have already been mentioned there are many deposits in New York which are not at present of commercial importance. These may be roughly classified as metallic minerals and non-metallic minerals.

METALLIC MINERALS

In this class are iron pyrites, arsenopyrite, chromite, chalcopyrite, cuprite, galenite, cerusite, sphalerite, wad or bog manganese, millerite and molybdenite. The galenite and pyrites have respectively yielded small quantities of silver and gold at certain places, but *at no locality in New York have enough of the precious metals been found at any time to pay for the expense of extracting them.* From time to time capital is invested for the purpose of gold or silver mining in New York, but always without practical results. The experience of 50 years has shown that neither in New York nor in New England have either of the metals been found in paying quantities.

The following is a list of the principal localities at which the various metallic minerals are found:

IRON, SULPHUR, ARSENIC

Pyrite, iron pyrites, bisulphide of iron. Anthony's nose, Westchester county, mine formerly worked; Philips ore bed, Phillipstown, Patterson, southeast of Carmel and near Ludington mills, in Putnam county; with galena at Wurtsboro lead mine, Sullivan county; Flat creek, Montgomery county; near Canton, St Lawrence county, in extensive beds; Duane, Franklin county, large bed; Martinsburg, Lewis county; Eighteen mile creek, Erie county, and many other localities, sparingly in rocks.

Arsenopyrite, mispickel. Near Edenville, Orange county, with arsenical iron and orpiment, in a vein in white limestone; near Pine pond in Kent, and near Boyd's Corner, Putnam county. These localities have been opened, but not worked for arsenic.

Chromite, chrome iron ore. In serpentine, Phillipstown, Putnam county; Wilks' mine, Monroe, Orange county.

COPPER

Chalcopyrite, copper pyrites; sulphide of iron and copper. Ancram lead mine, Columbia county; Bockee mine, Columbia county; near Edenville, Orange county; with arsenopyrite; near Wurtsboro, Sullivan county, with galena in considerable abundance; Ellenville and Red Ridge lead mines, Ulster county; near Rossie, and also near Canton, in St Lawrence county, once worked. Many additional occurrences are reported where it is in small quantity.

Cuprite, red oxide of copper. Near Ladentown, Rockland county, in thin seams, in trap rock.

LEAD

Galenite, galena; sulphide of lead. Otisville, Orange county; Ellenville and Red Bridge, Ulster county; with copper pyrites and blende, in a gangue of quartz in Oneida conglomerate, mines no longer worked; Wurtsboro, Sullivan county; near Sing Sing, in Westchester county; northeast township, Dutchess county; Ancram, Columbia county; strings of galena, blende and pyrites in limestone; White creek, Washington county; Martinsburg, Lewis county; Spraker's basin, Montgomery county; Rossie and vicinity, St Lawrence county; *mines largely worked years ago;* ore occurs in vein with blend, pyrites and copper pyrites. These mines have all been idle for several years.

Cerusite, carbonate of lead. Rossie, Robinson, Ross and other lead mines, in St Lawrence county; Martinsburg, Lewis county; near Sing Sing, on Hudson, associated with galena, in small quantity.

ZINC

Sphalerite, zinc blende; sulphide of zinc. Associated with galena at lead mines in Sullivan, Ulster and Orange counties; Ancram, Columbia county; Flat creek, Montgomery county; Salisbury, Herkimer county; Martinsburg, Lewisburg, Lewis county; Cooper's Falls, Mineral Point, and in Fowler, St Lawrence county.

MANGANESE

Wad, earthy manganese, bog manganese. In town of Austerlitz, Columbia county, are several localities; also in Hillsdale and Canaan, same county; smaller deposits near Houseville, Lewis county, and southeast of Warwick, Orange county.

NICKEL

Millerite, sulphide of nickel. Sterling iron mine, Antwerp, Jefferson county, famous for crystalline forms.

MOLYBDENUM

Molybdenite; sulphide of molybdenum. West Point and near Warwick, Orange county; Philips mine, Putnam county; Clinton county, but sparingly, in granite rocks.

NON-METALLIC MINERALS

Under the head of non-metallic minerals which have a commercial value but do not occur in New York in a quantity large enough to be of economic importance, may be enumerated apatite, asbestus, barite, biotite, calcite, fluorite, magnesite, muscovite and serpentine. The principal localities for these minerals are given herewith:

Apatite; phosphate of lime. Hammond, St Lawrence county, crystalline, with calcite, zinc ore and feldspar; near Gouverneur, St Lawrence county, crystals in calcite, Vrooman lake, Jefferson county; Greenfield, Saratoga county; near Hammondsville, Essex county; with magnetite in some of iron ores near Port Henry; other localities of occurrence.

Barite, barytes, heavy spar; sulphate of baryta. Ancram, Columbia county; near Schoharie Courthouse, with strontianite, in the

Water-lime group; Carlisle, Schoharie county; near Littlefalls and Fairfield, Herkimer county; near Syracuse, Onondaga county; Pillar Point, Jefferson county, in large veins; Hammond and De Kalb, St Lawrence county.

Calcite, calcareous tufa, travertine; carbonate of lime. Vicinity of Schoharie Courthouse, Schoharie county; Sharon Springs, a large deposit; Howe's Cave, Schoharie county; near Catskill, Greene county; head of Otsquaga creek, Stark, Herkimer county; Saratoga Springs; near Syracuse and in Onondaga valley, Onondaga county; between Camillus and Canton, same county; near Arkport, Steuben county; near Ellicott's mills, Erie county, and many lesser deposits.

Fluorite, fluor spar; fluoride of lime. Muscalonge lake, Alexandria, Jefferson county, very fine crystals; Lowville, Lewis county; Niagara county, at Lockport; Auburn, Cayuga county; Rossie and Mineral Point, St Lawrence county.

Magnesite, carbonate of magnesia. Near Rye, Westchester county; Warwick, Orange county; New Rochelle, Westchester county; Stony Point, Rockland county; Serpentine hills, Staten Island; everywhere in thin seams and strings.

Muscovite, mica. As a rock constituent, common. In large plates near Warwick and at Greenwood at Mount Bashan pond, in Orange county; Pleasantville, Westchester county, once opened and mined; Henderson, Jefferson county; Potsdam and Edwards, in St Lawrence county.

Serpentine. Staten Island, near New Rochelle and near Rye, Westchester county; Phillipstown, Putnam county; near Amity, Orange county, verd antique; Johnsburg and Warrensburg, Warren county; Shelving rock, Lake George, Washington county; Gouverneur, Fowler, Edwards and Pitcairn townships, in St Lawrence county; other localities of occurrence in small quantity.

COAL AND LIGNITE

Coal and lignite, while they occur in New York, can never be found in commercial quantities. The coal measures of Pennsylvania are not found north of the boundary line between Pennsyl-

vania and New York, and what coal has been discovered in the latter state is in older formations which do not contain this valuable mineral in commercial quantities. Many thousands of dollars have been spent in fruitless efforts to obtain coal in New York, but year after year men appear in the field who seem anxious to pay for their own experience. It can not be too strongly urged upon the attention of the people of the state that *it is absolutely useless to seek for coal in New York.*

Coal. Woodstock, Ulster county, thin vein in the Catskill, worked out; in seams interstratified with shale, in Chautauqua, Erie, Livingston and Seneca counties.

Lignite, brown coal. Near Rossville, Staten Island, thin seam in clay; also in Suffolk county in clays.

PART 4.

SUGGESTIONS FOR STUDY

GEOLOGIC TEXT-BOOKS AND BOOKS OF REFERENCE

Geology is not, like history, a subject which can be learned wholly from books. Not even an elementary knowledge of it can be readily obtained without careful field study of some prominent district. The student must, however, use books to supply him with information as to the work of others who have gone before, while his powers of observation and inference are being trained on geologic phenomena.

When taking up the field study of a new district, it is important to ascertain what is already known concerning it. An attempt is made, therefore, to direct attention to the principal publications on New York geology.

The four geologic reports of Hall, Mather, Emmons and Vanuxem on the districts assigned to them in the original survey of the state which was begun in 1837 and concluded in 1841, are now out of print, but are found in most of the public libraries of New York, and can be purchased of the dealers in old books in the larger cities. They contain an immense amount of valuable detail and should be consulted by all persons interested in New York geology. The report on the fourth district by James Hall, is as valuable to-day as when it was written and comparatively little has been added by later investigators in the region described, except in regard to quaternary and economic geology.

In addition to these four quarto volumes on the geology of New York, there have been many papers published in the annual reports of the New York State Museum and the State Geologist of New York. A multitude of papers have also been published by persons not officially connected with the State

Geologist or with the State Museum. These will be found in the publications of various scientific societies; the New York Academy of Sciences, the American Association for the Advancement of Science, the Geological Society of America and others; in the American Journal of Science, the American Geologist and other periodicals; and in the publications of the U. S. Geological Survey.

Prof. John M. Clarke, in the 13th report of the State Geologist for 1893, also in the 47th report of the New York State Museum, has published a list of papers on the geology of New York from 1876 to 1893.

Attention is also directed to Bulletin No. 127 of the U. S. Geological Survey, entitled Catalogue and Index of Contributions to North American Geology, 1732–1891, by N. H. Darton, price 60 cents.

For a proper understanding of the geographic distribution of the New York formations, a geologic map of the state is necessary. For general reference the large map prepared by the State Geologist is invaluable, and for field use, the small Economic and Geologic map is recommended. This may be purchased through the Secretary of the University of the State of New York for 25 cents per copy unmounted, or 75 cents dissected and mounted on muslin.

The invaluable *Geological Railway Guide* of MacFarlane, published by Appleton & Co., is commended as a guide in travel. Dana's *Manual of Geology* is also indispensable as a compendium and reference book on the geology of the United States. The most excellent *Text-book of Geology* by Sir Archibald Geikie is highly recommended for reference. The *Principles of Geology* by Sir Charles Lyell is a work of great value which should be read by all students and teachers. Dana's *Text-book of Geology* is very useful.

While many are deterred from the purchase of these volumes by their seeming high price, it is, after all, but a small sum to pay for the liberal education in geology which can be obtained through their judicious use.

In addition to the more technical books described above, there are many accurate and important works written for popular reading both at home and abroad. The number of these is constantly increasing and they can be found in the large libraries or obtained through the book sellers.

Field Work

OUTCROPS

There are in general two classes of geologic strata, the hard and the soft. In New York the hard strata include all rocks older than the Cretaceous. The soft include the formations of the Cretaceous, Tertiary and Quaternary. Almost everywhere the hard rocks are overlaid by soft deposits, usually of Quarternary age, so that in any locality there is generally both hard and soft geology.

The hard geology is probably best for the beginner to take up first, where he has a choice between the two. In Dana's *Manual of Geology* and Sir Archibald Geikie's *Outlines of Field Geology*, detailed directions are given for methods of study among the hard rocks.

The most important habit to be cultivated by the beginner in geology, is that of recognizing outcrops when they occur, or in their absence, of determining by surface indications the character of the rock which underlies the soil.

The beginner must form early, the habit of distinguishing loose fragments or boulders from ledges or outcrops, and in regions devoid of outcrops must study carefully the stone fences for fragments of the local rock. The fences as a rule represent the aggregate of loose rock fragments gathered from the surface of the agricultural lands and these fragments have usually come from the underlying rock. In parts of western New York, over the soft Salina shales no fragments of local rock are found because it decomposes into clay. There the fences are formed of small, hard cobblestones chiefly derived from the granite and gneiss rocks of Canada and brought to their present resting place by the great ice sheet.

Where the covering of soil and other loose material is thick, outcrops should be sought along the beds of rivers, creeks and rivulets. Running water usually cuts through the softer material and reaches the harder rock below. For this reason the gutters and ditches by the sides of roads should be examined for exposures, if no other source of information is available.

It is not possible here to give any adequate directions for the study of soft geology. This branch is still immature and is chiefly in the hands of specialists. The literature of Quaternary geology is, however, very large and by a careful study of it, the beginner may form some conception of its scope. A single field day with a good geologist is worth more than many weeks of reading.

FOSSILS

It is important for the beginner to realize that perfect specimens of fossils such as are exhibited in the museums and figured in the works on palaeontology are not every where to be found and that the more common examples are fragmentary. Were it not for the dissolving action of atmospheric water on carbonate of lime the study of fossils would still be in its infancy, as in many cases the fossil is wholly inclosed in a firm mass of limestone from which it can not be separated by the hammer alone. On the surface exposures of limestone, the action of the weather removes a part of the matrix, exposing for a time the surface of the shell. This after a few years may in turn yield to the dissolving action of atmospheric water and gradually disappear, another specimen at a lower level being gradually brought to view in its place. In sandstones, the calcareous fossils are usually entirely dissolved out of the surface layers and it is only by the impressions or casts which they leave behind, that we know of their existence. If means are afforded for excavation and blasting, below the reach of the rain water, will be found a bed of rock from which the calcareous matter has not been dissolved away, but in this case it is often difficult to separate the fossils except by long and tedious process of cleaning or developing with small tools.

Within the writer's observation, students at the beginning of their field experience are misled by the perfection of cabinet specimens and figures and hope to find everywhere such perfect forms; as a matter of fact, they must learn to be guided for the most part by fragments.

It does not seem possible to give within the limits of this publication any adequate description of the fossils which are characteristic of the different strata. It is better for these to refer to the original publications of the New York Natural History Survey. In the four reports on geology by Mather, Emmons, Vanuxem and Hall, numerous illustrations of fossils are given but the names are, in many cases, out of date. In the volumes on Palaeontology from I to VII, are described and figured most of the fossils of New York state from the Potsdam sandstone to the Chemung. Volume VIII gives a revision of the Brachiopoda. To these volumes, therefore, the student should refer for the identification of such forms as he may find in his field excursions. A few of the more common species are figured in Dana's *Manual of Geology,* which should be in the hands of every student. For those pursuing more critical studies, the work of S. A. Miller on *North American Geology and Palaeontology* is of great value as it gives a complete list of all Palaeozoic fossils described up to the date of its publication and indicates the more modern names in the many cases where there has been a change of nomenclature. Of the eight volumes of New York palaeontology mentioned, the first two are out of print and are only to be had from dealers in second hand books, but they will probably be found in most of the public libraries of New York state. The remaining volumes are sold at $2.50 each.

THE NATURAL HISTORY SURVEY OF NEW YORK AND THE ORIGIN OF THE STATE MUSEUM

The New York State Museum, organized by act of legislature in 1870 under the title of the State Museum of Natural History and placed under the trusteeship of the Regents of the University, is the result of the geological survey of the state commenced in 1836.

This survey was established at the expressed wish of the people to have some definite and positive knowledge of the mineral resources and the vegetable and animal productions of the state.

Hon. Stephen Van Rensselaer was the patron of the first enterprise of this kind, and had published much valuable information, but it was felt that a more thorough investigation was needed. The idea was fully expressed in a memorial presented by the Albany Institute to the state legislature in 1834, in which the object was thus stated: 'to form a grand and comprehensive collection of the natural productions of the state of New York; to exhibit at one view, and under one roof, its animal, vegetable and mineral wealth.'

In 1835 the New York Lyceum of Natural History presented a memorial to the legislature on the same subject, and it is presumed that this memorial and the influences prompting the request of the Albany Institute, induced the legislature of 1835 to pass a resolution requesting the secretary of state to report to that body a plan for 'a complete geological survey of the state, which should furnish a scientific and perfect account of its rocks, soils and minerals; also a list of its mineralogical, botanical and zoological productions, and provide for procuring and preserving specimens of the same, etc.'

Pursuant to this request, Hon. John A. Dix, then secretary of state, presented to the legislature of 1836, a report proposing a plan for a complete geological, botanical and zoological survey of the state.

The scientific staff of the natural history survey of 1837 was appointed by Governor Seward pursuant to an act of the legislature, and consisted of John Torrey, botanist, James E. De Kay, zoologist, Lewis C. Beck, mineralogist, W. W. Mather, Ebenezer Emmons, Lardner Vanuxem and James Hall, geologists, and Timothy A. Conrad, paleontologist. The state was divided into four districts, each of which was assigned to a geologist in the order given.

The heads of the several departments reported annually to the governor the results of their investigations, and these constituted

the annual octavo reports which were published from 1837 to 1841. The final reports were published in quarto form, beginning at the close of the field work in 1841, and 3,000 sets have been distributed, comprising four volumes of geology, one of mineralogy, two of botany, five of zoology, five of agriculture and eight of palaeontology.

The collections in the several departments were supposed to require a room of some magnitude, and it was thought that such could be found in the third story of the old capitol, by taking away a partition and throwing into one, two rooms used by committees; but long before the completion of the survey it was evident that the collections would require much more space than the capitol rooms would afford, and in 1840 Gov. Seward, in response to a memorial urging 'the importance of providing suitable rooms or a separate building for the collections made during the survey,' recommended that the old State hall on the corner of State and Lodge streets be used for that purpose.

This old building was replaced in 1857 by a new one, Geological and Agricultural hall, and the collections which at first were to find place in two committee rooms, now occupy a large part of the main floor and three entire floors above, besides storage accommodations in the basement.

These collections form a scientific museum of great interest and value, and its publications are recognized among the works of standard authority in science. The geological survey of New York has been comprehensive and extended, yet some portions of the work are still incomplete; the northern part of the state has been but partially studied, and its geologic structure is but imperfectly known.

This museum, with its extensive and increasing collections and publications, plays an important part in the educational system of the state, since the importance of this kind of education has become so fully and generally recognized.

Although neither coal nor mines of gold or silver have been found within the state, it has been shown that New York possesses the most complete and unbroken series of the Palaeozoic

or older fossiliferous rocks known in the world; and that for these the collections of the museum with the nomenclature adopted by the geological survey of New York will always be the standard of reference and authority.

It may justly be said that Hon. John A. Dix, as secretary of state, in 1836 laid the foundation of this museum and of all the scientific and practical results which have accrued from the inauguration of the geological survey of the state of New York.

At the time of the final arrangement of the collections of the geological survey, in 1843, very little was known in this country regarding museums of natural history, and no true appreciation of what such an institution should be, existed, except in the minds of a few persons. It is not strange, therefore, that there should have been a general acquiesence in the proposition that the collections of the geological survey should be deposited in the old State hall for 'safe keeping,' and the idea of constant and steady increase toward a great museum of natural history was scarcely, if at all promulgated. The collections and the rooms that they occupied were placed in charge of a curator, Mr. J. W. Taylor, who was succeeded by Mr. John Gebhard, Jr, and he in turn in 1857 by Colonel Jewett. The small annual appropriations made by the legislature were only sufficient for the custody and very moderate increase of the collection. Matters remained in this condition till 1865, when the legislature passed some resolutions tending to the expansion of the museum; and, following these, the secretary of the board of regents addressed a circular letter to numerous scientific men, professors and teachers, asking suggestions as to the best mode of putting in force the objects of the legislature as expressed in the resolutions referred to.

The communications in reply to this were published in the 19th report of the State Cabinet, together with a recommendation of the committee of the regents to whom the subject had been referred. This recommendation became the first step toward an improved condition, and a recognition of the necessity of regarding the museum as a series of collections in natural history which were to be increased and elaborated in every de-

partment. In 1865 Col. Jewett resigned and was succeeded by James Hall.

The discovery of the mastodon skeleton at Cohoes, in the summer of 1866, and its acquisition by the State Cabinet, attracted much attention toward the institution. At the next legislature successful application was made for $5,000 to purchase the Gould collection of shells and this accession of 60,000 specimens representing 6,000 species was generally appreciated.

The new capitol commissioners, wishing information as to the sources of building material, engaged the curator of the State Cabinet to make a reconnaissance which resulted in a report to the commissioners, and the acquisition to the State Cabinet, by this and other means, of a large collection of marbles, limestones, sandstones and granites which are now included in the collection which occupies two sides of the entrance hall of the museum.

At first the State Cabinet received no regular or fixed appropriation of money from the legislature, but in 1870 a law was passed organizing the same, under the designation of the State Museum of Natural History, and appropriating $10,000 annually to provide for the salaries of the director and three assistants, together with the expenses of increase and preservation of the collections. In addition to this, a sum was annually appropriated for the salary of a botanist, and special appropriations have been made from time to time.

In 1881 a state entomologist was appointed and in 1883 was made a member of the museum staff.

The present appropriation of $12,000 is quite inadequate to the requirements of such a museum, but a visible and substantial progress is made in each of the departments, as shown in the increasing order and the additions to the collections, as recorded in the annual museum reports.

In 1889 the State Museum was made an integral part of the University of the State of New York. In 1894 the present director was appointed. Most of the museum remains on the four floors of Geological hall on State street, at the corner of Lodge. Here are the collections in mineralogy, geology, palaeontology, zoology and ethnology and the offices of the director and his assistants. The state geologist and palaeontolo-

gist and his staff have their offices in State hall in Eagle street, and the entomologist and botanist are in the north east section of the fourth floor of the capitol. The State Museum in addition to its work of collecting material representative of the natural resources of the state, is also the seat of the geologic and natural history survey which has been in progress since 1832, and under the auspices of which numerous reports have been published on geology, palaeontology, zoology and botany. The museum is open to the public from 9 a. m. till 5 p. m. daily except on Sundays and other holidays.

Inasmuch as the State Museum comprises all scientific work intrusted to the regents it is proper to mention the resurvey of the boundary line between New York and the states of New Jersey and Pennsylvania. This was done in accordance with resolutions passed by the legislature in 1867 and in 1875, and by the laws of 1880 the boundary lines resurveyed and monumented under the direction of the regents were accepted as the true boundaries of the state.

OFFICERS OF THE STATE MUSEUM

Administrative division

Frederick J. H. Merrill, Ph. D. (Columbia)............Director
A. G. Richmond..............Honorary curator in archaeology
J. N. Nevius.................................Assistant
Joseph Morje...................................Page

Research division

†James Hall, M. A. (Rensselaer polytechnic) LL. D. (Harvard)
State geologist and paleontologist
Charles H. Peck, M. A. (Union).................State botanist
*J. A. Lintner, Ph. D. (N. Y.)...............State entomologist
John M. Clarke, M. A. (Amherst)
Assistant state geologist and paleontologist

Philip Ast........................Lithographer	Geologist's assistants
George B. Simpson...................Draftsman	
Martin Sheehy.......................Messenger	
Jacob Van Deloo.........................Clerk	

Ephraim Porter Felt, B. S. (Boston) Sc. D. (Cornell)
Entomologist's assistant

* Died May 5, 1898.
† Died August 7, 1898.

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Igneous.

Archaean or Precambrian.

Cambrian.

Lower Silurian.

Upper Silurian.

Devonian.

Triassic.

Quaternary.

Economic.

(Pages 263–4 were bulletin cover pages)

REPORT

OF THE

STATE BOTANIST

1897

REPORT

OF THE

STATE BOTANIST

1897

To the Honorable the Regents of the University of the State of New York

GENTLEMEN: I have the honor of submitting to you the following report.

Since the date of my last report, specimens of plants of the state have been collected by the botanist in the counties of Albany, Essex, Rensselaer, Saratoga and Ulster.

Specimens have been received from correspondents who collected them in the counties of Cayuga, Dutchess, Essex, Genesee, Hamilton, Monroe, Onondaga, St Lawrence and Suffolk.

The whole number of species represented by the specimens added to the herbarium is 279, of which 258 are represented by the collections of the botanist, 21 by those of his correspondents. The number of species new to the herbarium is 49, of which 42 are represented by collected specimens, 7 by contributed specimens. Among these are 26 species which are considered new to science and are therefore described as new species.

A list of the names of the species of which specimens have been added to the herbarium is marked A.

A list of the names of the species of which specimens have been contributed or received for identification, together with the names of their respective contributors is marked B.

A record has been made of the species new to our flora, giving the locality in which they were found and the time of their collection,

together with other matter of interest concerning them. Descriptions have also been written of the new species. A few plants previously reported as varieties of recorded species, having been raised or restored to specific rank in the *Illustrated flora of the Northern states and Canada,* are now recognized as species not before reported. This part of the report is marked C.

A part of the report giving the results of recent observations on certain plants previously reported is marked D.

Inquiries for a catalogue of the plants of North Elba having been received, and that locality being in the heart of a region of much botanical as well as public interest, it was thought desirable that a list of these plants should be prepared in connection with the investigation of this part of the flora of our state. Parts of the months of June and of August were spent in the investigation of the flora of this town and in making a record of the species observed. Many early herbaceous plants which may be seen in June have disappeared by midsummer, and many later ones which are just beginning to develop in June are in good condition for identification in August.

It is scarcely to be expected that anything more than an approximate list of the plants of so large a town, some parts of which are not easily accessible, could be made in so short a time. A considerable area of the southern and northwestern part of the town was not visited. These parts are rugged and mountainous and covered by extensive forests whose exploration would necessitate a camping outfit and the continuous service of a guide, and would be attended by greater expense than I felt justified in incurring at the present time.

It was my purpose to make this list include not only flowering plants and ferns but also mosses, lichens and fungi. Lack of time for its completion will compel me either to limit it to the flowering

plants and ferns for this report and to complete it in another, or else to prepare the whole for a later report or bulletin. The latter course seems to me the better.

The investigation of the species of edible mushrooms of the state has continued to receive attention. Those species that were unusually abundant last year have been unusually scarce this year. The common mushroom has scarcely appeared except in single and very rare examples. With these, as with some cultivated plants, there seems to be what are commonly called off years, which follow fruitful ones. In such years the conditions appear to be unfavorable to a full crop. Other species which were not remarkable for their abundance last year, have been plentiful this year. Several of these have been tested and have been considered worthy of admission into the list of edible species. Descriptions of 11 of these will be found in a part of the report marked E. The species have been illustrated by figures of natural size on plates of the same dimensions as those previously published in illustrating our edible and poisonous mushrooms.

Respectfully submitted

Charles H. Peck

State botanist

Albany, December 29, 1897

A

PLANTS ADDED TO THE HERBARIUM

New to the herbarium

Brassica juncea *Cosson*
Euonymus Europaeus *L.*
Poterium Sanguisorba *L.*
Agrimonia mollis *Britton*
Crataegus mollis *Scheele*
Amelanchier rotundifolia *Roem.*
Solidago Virgaurea *L.*
Picea brevifolia *Pk.*
Salix balsamifera *Barratt*
Panicum boreale *Nash*
P. lanuginosum *Ell.*
Hypnum Jamesii *L. & J.*
Lepiota acerina *Pk.*
Clitocybe gilva *Pers.*
C. monadelpha *Morg.*
C. fellea *Pk.*
Mycena cyaneobasis *Pk.*
Omphalia clavata *Pk.*
O. papillata *Pk.*
Marasmius ramulinus *Pk.*
M. subnudus (*Ellis*) *Pk.*
M. vialis *Pk.*
Clitopilus popinalis *Fr.*
Leptonia subserrulata *Pk.*
Flammula viscida *Pk.*
Pholiota lutea *Pk.*
P. marginella *Pk.*
Inocybe rigidipes *Pk.*
I. albodisca *Pk.*
Tubaria deformata *Pk.*
Deconica semistriata *Pk.*
Gomphidius vinicolor *Pk.*
Hygrophorus immutabilis *Pk.*
Clavaria fellea *Pk.*
Boletus nebulosus *Pk.*
Poria setigera *Pk.*
Trametes serialis *Fr.*
Hydnum chrysocomum *Underw.*
Cyphella fasciculata *B. & C.*
Geaster velutinus *Atk.*
Catastoma circumscissum *Morg.*
Lycoperdon cepiforme *Bull.*
Isaria penicilliformis *Pk.*
Cercospora caricina *E. & D.*
Exoascus Insititiae *Sadeb.*
E. unilateralis *Pk.*
Hypocrea aurantiaca *Pk.*
Peziza odorata *Pk.*
Sphaerella Cypripedii *Pk.*

Not new to the herbarium

Thalictrum polygamum *Muhl.*
Capnoides sempervirens *Borck.*
Dentaria diphylla *Mx.*
Viola obliqua *Hill.*
V. pubescens *Ait.*
V. rostrata *Pursh.*
V. Labradorica *Schrank.*
Hypericum ellipticum *Hook.*
Arenaria stricta *Mx.*
A. Groenlandica *Spreng.*
Buda marina *Dumort.*
Claytonia Virginica *L.*
Tilia Americana *L.*
Oxalis cymosa *Small.*
Xanthoxylum Americanum *Mill.*
Ilex monticola *Gr.*
Acer rubrum *L.*
A. nigrum *Mx.*
A. Pennsylvanicum *L.*
Staphylea trifolia *L.*
Trifolium incarnatum *L.*
Lespedeza hirta *Ell.*
Rubus villosus *Ait.*
R. Allegheniensis *Porter*
R. Millspaughii *Britton*
R. Canadensis *L.*

Rubus setosus *Bigel.*
Spiraea tomentosa *L.*
S. salicifolia *L.*
Crataegus tomentosa *L.*
C. macracantha *Lodd.*
Tiarella cordifolia *L.*
Mitella diphylla *L.*
Penthorum sedoides *L.*
Saxifraga Pennsylvanica *L.*
Ribes rotundifolium *Mx.*
Kneiffia pumila *Spach.*
Aralia nudicaulis *L.*
Viburnum alnifolium *Marsh.*
V. pubescens *Pursh*
Galium Aparine *L.*
G. boreale *L.*
Symphoricarpos racemosus *Mx.*
Lonicera hirsuta *Eaton*
Solidago neglecta *T. & G.*
S. rugosa *Mill.*
Aster acuminatus *Mx.*
A. Lowrieanus *Porter*
A. Novi-Belgii *L.*
Heliopsis helianthoides *B. S. P.*
Helianthus decapetalus *L.*
Tragopogon porrifolius *L.*
Senecio aureus *L.*
S. Robbinsii *Oakes*
Hieracium Pilosella *L.*
H. aurantiacum *L.*
Lobelia inflata *L.*
Kalmia latifolia *L.*
Xolisma ligustrina *Britton*
Vaccinium Pennsylvanicum *Lam.*
Chiogenes hispidula *T. & G.*
Pyrola secunda *L.*
Lysimachia terrestris *B. S. P.*
Hydrophyllum Canadense *L.*
Apocynum cannabinum *L.*
Gentiana Andrewsii *Griseb.*
Echium vulgare *L.*
Symphytum officinale *L.*
Physalis lanceolata *Mx.*
Veronica officinalis *L.*
Nepeta Glechoma *L*
Galeopsis Tetrahit *L.*
Anychia capillacea *DC.*
Polygonum cilinode *Mx.*
P. Pennsylvanicum *L.*
Fagopyrum Fagopyrum *Karst.*
Euphorbia nutans *Lag.*
E. maculata *L.*
Quercus Prinus *L.*
Q. macrocarpa *Mx.*
Q. platanoides *Sudw.*
Juglans regia *L.*
J. cinerea *L.*
Hicoria glabra *Britton*
H. alba *Britton*
Populus bals. candicans *Gr.*
Salix fluviatilis *Nutt.*
S. amygdaloides *Anders.*
S. sericea *Marsh.*
Betula lutea *Mx.*
Naias flexilis *R. & S.*
Hypoxis hirsuta *Cov.*
Sisyrinchium angustifolium *Mill.*
Habenaria orbiculata *Torr.*
Peramium pubescens *MacM.*
Liparis Loeselii *Rich.*
Polygonatum biflorum *Ell.*
P. commutatum *Dietr.*
Uvularia sessilifolia *L.*
Trillium undulatum *Willd.*
Juncoides campestre *Kuntze*
Eriophorum Virginicum *L.*
E. polystachyon *L.*
Carex arctata *Boott*
C. brunnescens *Poir.*
C. conoidea *Schk.*
C. crinita *Lam.*
C. flava *L.*
C. formosa *Dew.*
C. granularis *Muhl.*
C. laxiculmis *Schw.*
C. laxiflora *Lam.*
C. lurida *Wahl.*
C. platyphylla *Carey*
C. scabrata *Schw.*
C. sterilis *Willd.*
C. tenuis *Rudge*
C. triceps *Mx.*
C. vulpinoidea *Mx.*
C. xanthocarpa *Bick.*

Milium effusum *L.*
Syntherisma linearis *Nash*
Elymus striatus *Willd.*
Lycopodium lucidulum *Mx.*
Adiantum pedatum *L.*
Dryopteris spinulosa *Kuntze*
Asplenium acrostichoides *Sw.*
Isoetes ech. Braunii *Engelm.*
Tetraplodon mnioides *L. f.*
Asterella hemisphaerica *Bv.*
Amanita muscaria *L.*
A. phalloides *Fr.*
Amanitopsis vaginata *Roze*
A. farinosa (*Schw.*)
A. volvata (*Pk.*) *Sacc.*
Lepiota naucinoides *Pk.*
L. augustana *Britz.*
L. granulosa *Batsch.*
L. metulaespora *B. & Br.*
L. felina *Pers.*
L. rubrotincta *Pk.*
L. amianthina *Scop.*
L. granosa *Morg.*
Tricholoma Columbetta *Fr.*
T. alboflavidum *Pk.*
T. brevipes *Bull.*
T. laterarium *Pk.*
T. decorosum *Pk.*
T. terreum *Schaeff.*
Clitocybe clavipes *Pers.*
C. albissima *Pk.*
C. cyathiformis *Fr.*
C. Adirondackensis *Pk.*
Collybia maculata *A. & S.*
C. stipitaria *Fr.*
C. zonata *Pk.*
C. confluens *Pers.*
C. velutipes *Curt.*
C. Hariolorum *DC.*
Pleurotus ostreatus *Fr.*
P. serotinus *Schrad.*
Hygrophorus eburneus *Fr.*
H. nitidus *B. & C.*
H. borealis *Pk.*
Lactarius aquifluus *Pk.*
L. fuliginosus *Fr.*
L. glyciosmus *Fr.*
Lactarius hygrophoroides *B. & C.*
Russula emetica *Fr.*
R. crustosa *Pk.*
R. chameleontina *Fr.*
Cantharellus cinnabarinus *Schw.*
C. dichotomus *Pk.*
C. infundibuliformis *Scop.*
C. aurantiacus *Fr.*
Marasmius polyphyllus *Pk.*
M. campanulatus *Pk.*
Lenzites betulina *Fr.*
L. sepiaria *Fr.*
Lentinus Lecontei *Schw.*
L. suavissimus *Fr.*
Pluteus cervinus *Schaeff.*
P. umbrosus *Pers.*
P. admirabilis *Pk.*
Clitopilus Noveboracensis *Pk.*
Claudopus nidulans (*Pers.*)
Hebeloma glutinosum *Fr.*
Galera tenera *Schaeff.*
Flammula sapineus *Fr.*
F. Highlandensis *Pk.*
Agaricus campester *L.*
A. arvensis *Schaeff.*
A. Rodmani *Pk.*
Hypholoma incertum *Pk.*
H. hymenocephalum *Pk.*
Coprinus plicatilis *Fr.*
Boletus illudens *Pk.*
B. piperatus *Bull.*
B. Clintonianus *Pk.*
B. subtomentosus *L.*
B. vermiculosus *Pk.*
B. scaber *Fr.*
B. gracilis *Pk.*
Polyporus brumalis *Fr.*
P. Schweinitzii *Fr.*
P. elegans *Fr.*
P. albellus *Pk.*
P. fumosus *Fr.*
P. borealis *Fr.*
Fomes conchatus *Fr.*
F. carneus *Nees.*
Polystictus biformis *Kl.*
P. zonatus *Fr.*
Poria fimbriatella *Pk.*

Poria sanguinolenta *Fr.*
Daedalea unicolor *Fr.*
Trametes scutellata (*Schw.*)
Favolus Canadensis *Kl.*
Merulius tenuis *Pk.*
M. tremellosus *Schrad.*
Hydnum graveolens *Del.*
Irpex lacteus *Fr.*
Thelephora pedicellata *Schw.*
Stereum hirsutum *Fr.*
S. rugosum *Fr.*
S. fasciatum *Schw.*
Clavaria pinophila *Pk.*
Physalacria inflata *Pk.*
Anthurus borealis *Burt.*
Mitremyces lutescens *Schw.*
Lycoperdon giganteum *Batsch.*

B

CONTRIBUTORS AND THEIR CONTRIBUTIONS

Mrs E. C. Anthony, Gouverneur, N. Y.

Polyporus umbellatus *Fr.*
Helvella elastica *Bull.*

Mrs L. A. Millington, New Russia, N. Y.

Geaster radicans *B. & C.*
Geaster velutinus *Atk.*

Miss M. L. Overacker, Syracuse, N. Y.

Symphoricarpos racemosus pauciflorus *Robbins.*

Mrs L. L. Goodrich, Syracuse, N. Y.

Viola blanda *Willd.*
V. pubescens *Ait.*
V. scabriuscula *Schw.*
V. rostrata *Muhl.*
V. striata *Ait.*
V. obliqua *Hill.*
V. palmata *L.*
Malus coronaria (*L.*) *Mill.*
Mitella diphylla *L.*
Waldsteinia fragarioides *Tratt.*
Arisaema triphyllum *Torr.*
Trillium grandiflorum *Salisb.*
Asplenium Trichomanes *L.*

J. J. Davis, Racine, Wis.

Burrillia globulifera *Davis.*

George F. Atkinson, Ithaca, N. Y.

Polyporus umbellatus *Fr.*
P. lacteus *Fr.*
Poria aurea *Pk.*
Ramularia Fagopyri *Atk.*

Charles E. Smith, Philadelphia, Pa.

Carex bullata *Schk.*

J. A. Lintner, Albany, N. Y.

Bryophyllum calycinum *Salisb.*
Argemone Mexicana *L.*
Nerium Oleander *L.*
Juniperus Bermudiana *L.*
Sisyrinchium Bermudianum *L.*

Charles McIlvaine, Philadelphia, Pa.

Clavaria inaequalis *Mull.*
C. aurantio-cinnabarina *Schw.*
Boletus parasiticus *Bull.*

C. G. Lloyd, Cincinnati, O.

Lenzites protracta *Fr.*
L. vialis *Pk.*
Polyporus sanguineus *Fr.*
P. subpulverulentus *B. & C.*
P. pubescens *Fr.*
Polystictus ectypus *B. & C.*
P. barbatulus *B. & C.*
P. lilacinus *E. & E.*
Trametes hydnoides *Fr.*
T. Sepium *Berk.*
Fomes Curtisii *Berk.*
F. marmoratus *Berk.*
Merulius Corium *Fr.*
Hymenochaete corrugata *Lev.*
Stereum Curtisii *Berk.*
S. ochraceoflavum *Schw.*
S. albobadium *Schw.*
Peniophora cinerea *Cke.*
P. purpurea *C. & M.*
Irpex laeticolor *B. & C.*
I. bicolor *B. & C.*
Hypochnus albocinctus *Mont.*
Lycoperdon Curtisii *Berk.*
L. asterospermum *D. & M.*
Bovistella Ohiensis *E. & M.*
Catastoma circumscissum *B. & C.*
Hypocrea citrina *Fr.*
Helotium citrinum *Hedw.*

John Mather, Le Roy, N. Y.

Polyporus Berkeleyi *Fr.*
P. lucidus *Leys.*
Hydnum adustum *Schw.*

Mrs N. L. Britton, New Dorp, N. Y.

Sphagnum acutifolium *Ehrh.*
S. squarrosum *Pers.*
S. recurvum *Br.*
S. Russowii *Warnst.*
S. medium *Limpr.*
S. Girgensohnii *Russ.*
S. sedoides *Brid.*
Andraea petrophila *Ehrh.*
Dicranella heteromalla *Schimp.*
Dicranum montanum *Hedw.*
D. viride *Schimp.*
D. flagellare *Hedw.*
D. longifolium *Hedw.*
D. fuscescens *Turn.*
Dicranodontium longirostre *B. & S.*
Racomitrium Sudeticum *B. & S.*
R. fasciculare *Brid.*
R. microcarpum *Brid.*
Ulota Ludwigii *Brid.*
U. crispula *Brid.*
Georgia pellucida *Rabh.*
Tetraplodon mnioides *B. & S.*
Bartramia pomiformis *Hedw.*
Bryum roseum *Schreb.*
B. concinnatum *Spruce*
B. crudum *Schreb.*
Mnium spinulosum *B. & S.*
M. punctatum *Hedw.*
Pogonatum alpinum *Roehl.*
Buxbaumia indusiata *Brid.*
Fontinalis antipyretica *L.*
Homalia Jamesii *Schimp.*
Myurella Careyana *Sulliv.*
Anomodon apiculatus *B. & S.*
Pylaisia velutina *B. & S.*
Climacium Americanum *Brid.*
C. dendroides *B. & S.*
Brachythecium laetum *Brid.*
B. salebrosum *Hoffm.*
B. velutinum *L.*
B. Starkii *Brid.*
B. Novae-Angliae *S. & L.*
B. rivulare *Bruch.*
Rhynchostegium rusciforme *Weis.*
Raphidostegium recurvans *Schwaegr.*
R. Jamesii *L. & J.*
R. laxepatulum *L. & J.*
Plagiothecium pulchellum *Dicks.*
P. denticulatum *L.*
P. Muhlenbeckii *Spruce*
Harpidium fluitans *L.*
H. uncinatum *Hedw.*
Limnobium ochraceum *Turn.*

Eurhynchium strigosum *Hoffm.*
Pleurozium umbratum *Ehrh.*
Calliergon Schreberi *Willd.*
Hypnum reptile *Mx.*
H. Haldanianum *Grev.*

Fred. J. Braendle, Washington, D. C.

Anychia dichotoma *Mx.*
Lepiota Morgani *Pk.*
Merulius rubellus *Pk.*
Tricholoma multiceps *Pk.*
Scorias spongiosa *Fr.*

Stewart H. Burnham, Vaughns, N. Y.

Rubus Baileyanus *Britton*
Crataegus tomentosa *L.*
Solidago neglecta *T. & G.*
Echium vulgare *L.*
Carex straminea *Willd.*
C. formosa *Dew.*
C. costellata *Britton*
C. pedicellata *Britton*

Mrs A. M. Smith, Brooklyn, N. Y.

Dicranodontium longirostre *B. & S.*
Trematodon ambiguum *Hornsch.*
Funaria hygrometrica *Sibth.*

Fred. Thorne, New Paltz, N. Y.

Arisaema triphyllum pusillum *Pk.*

Frank R. Rathbun, Auburn, N. Y.

Hydnum Caput-ursi *Fr.*
H. coralloides *Scop.*
Clitocybe multiceps *Pk.*

B. L. Robinson, Cambridge, Mass.

Ranunculus Alleghaniensis *Britton*
Polygala puberula *Ands.*
Rosa humilis *Marsh.*
Rubus Canadensis *L.*
Sullivantia Ohiensis *T. & G.*
Pimpinella Saxifraga *Koch.*
Aralia hispida *Vent.*
Galium asprellum *Mx.*
Aster umbellatus *Mill.*
A. puniceus *L.*
A. sagittifolius *Willd.*
Solidago rugosa *Mill.*
S. Virgaurea *L.*
Cnicus muticus *Pursh*
Prenanthes serpent. nana *Gr.*
Andromeda polifolia *L.*
Plantago maritima *L.*
Chelone glabra *L.*
Brunella vulgaris *L.*
Mentha gentilis *L.*
M. longifolia *Huds.*
M. alopecuroides *Hull.*
Lemna Valdiviana *Phil.*
Habenaria psycodes *Gr.*
H. dilatata *Gr.*
Goodyera repens *R. Br.*
Triglochin maritimum *L.*
Juncus trifidus *L.*
J. Canad. brevicaudatus *Engelm.*
Luzula parv. melanocarpa *Gr.*
L. sylvatica *Beck.*
Cyperus cylindricus *Britton*
Scirpus caespitosus *L.*
Carex salina *Wahl.*
C. maritima *Mull.*
C. subulata *Mx.*
C. Willdenovii *Schk.*
C. aquatilis *Wahl.*
C. rigida *Good.*
C. praecox *Jacq.*
C. livida *Willd.*
C. tetanica *Schk.*
C. granularis *Muhl.*
C. plantaginea *Lam.*
C. Richardsonii *R. Br.*
C. pubescens *Muhl.*

Carex canes. alpicola *Wahl.*
C. Fraseri *Andr.*
C. stram. invisa *Boott*
C. gynandra *Schw.*
C. stipata *Muhl.*
C. intumescens *Rudge*
C. oligosperma *Mx.*
C. Raeana *Boott*
C. Magellanica *Lam.*
Calamagrostis Canadensis *Bv.*
Agrostis scabra *Willd.*
Triodia decumbens *Bv.*
Lycopodium Selago *L.*
L. annot. pungens *Spring.*
Pteris aquilina *L.*
Phegopteris Dryopteris *Fee.*
Gleichenia pectinata *Presl.*
Trichomanes pectinatum *Hedw.*
Camptosorus rhizophyllus *Lk.*
Marsilia mollis *Rob. & Fern.*

G. H. Nye and W. G. Cowell, Auburn, N. Y.

Hydnum coralloides *Scop.*
H. Caput-ursi *Fr.*
Hydnum septentrionale *Fr.*
Polyporus Anax *Berk.*

E. A. Burt, Middlebury, Vt.

Cortinarius pulchrifolius *Pk.*
C. squamulosus *Pk.*
Trametes serialis *Fr.*

A. J. Perkins, Rochester, N. Y.

Hydnum coralloides *Scop.*

Miss Grace Sturtevant, South Framingham, Mass.

Boletinus pictus *Pk.*
B. porosus (*Berk.*) *Pk.*
Boletus Frostii *Russ.*
B. pallidus *Frost*
B. parasiticus *Bull.*
B. griseus *Frost*
B. Peckii *Frost*
Boletus ornatipes *Pk.*
B. subaureus *Pk.*
B. auriporus *Pk.*
B. Russellii *Frost*
B. castaneus *Bull.*
Strobilomyces strobilaceus (*Scop.*) *Berk.*

George D. Hulst, Brooklyn, N. Y.

Aconitum reclinatum *Gr.*
Clematis Viorna *L.*
C. ochroleuca *Ait.*
Ranunculus reptans *L.*
Nymphaea Kalmiana *Sims*
Diplotaxis tenuifolia *DC.*
Lechea maritima *Leggett*
Althea officinalis *L.*
Malva moschata *L.*
Drosera filiformis *Raf.*
D. brevifolia *Pursh*
Moehringia lateriflora *Fenzl.*
Alsine graminea *Britton*
A. longifolia *Britton*
Rhus radicans *L.*
Falcata comosa *Kuntze*
Baptisia perfoliata *Br.*
Cytisus scoparius *Lk.*
Hydrangea arborescens *L.*
Epilobium lineare *Muhl.*
Myriophyllum spicatum *L.*
Eryngium Virginianum *Lam.*
Lacinaria squarrosa *Hill.*
Eupatorium album *L.*
Solidago squarrosa *Muhl.*
S. monticola *T. & G.*
Aster tenuifolius *L.*
A. nemoralis *Ait.*

Leontodon autumnale *L.*
Lobelia Kalmii *L.*
Clethra acuminata *Mx.*
Cynanchum nigrum *Pers.*
Gerardia tenuifolia *Vahl.*
Koellia hyssopifolia *Britton*
Plantago Virginica *B. S. P.*
P. aristata *Mx*,
Bartonia Virginica *B. S. P.*
Polygonella articulata *Meisn.*
Samolus floribundus *H. B. K.*
Euphorbia Cyparissias *L.*
E. Ipecacuanhae *L.*
Mercurialis annuus *L.*
Broussonetia papyrifera *L.*
Quercus nana *Sarg.*
Phoradendron flavescens *Nutt.*
Sparganium simp. angustifolium *Engel.*
Potamogeton perfoliatus *L.*
P. amplifolius *Tuckm.*
P. zosteraefolius *Schum.*
P. heterophyllus *Schreb.*
Limodorum tuberosum *L.*
Pogonia ophioglossoides *Ker.*
P. verticillata *Nutt.*
P. trianthophora *B. S. P.*
Peramium repens *Salisb.*
Corallorhiza multiflora *Nutt.*
Smilax glauca *Walt.*
Vagnera stellata *Morong*
Aletris farinosa *L.*
Veratrum Woodii *Robbins*
Chrosperma muscaetoxica *Kuntze*
Chamaelirium luteum *Gr.*
Gemmingia Chinensis *Kuntze*
Juncus maritimus *Lam.*
Scirpus robustus *Pursh*
Rynchospora alba *Vahl.*
Schoenocaulon gracile *Gr.*
Carex extensa *Gooden.*
Eriocaulon gnaphalioides *Mx.*
E. decangulare *L.*
Cenchrus tribuloides *L.*
Paspalum distichum *L.*
Distichlis spic. stricta *Scrib.*
Polypodium vulgare *L.*
Ophioglossum vulgatum *L.*

C

SPECIES NOT BEFORE REPORTED

Cardamine Pennsylvanica *Muhl.*

The Pennsylvania bitter cress has been confused in our botanies with the hairy bitter cress, *C. hirsuta*. It may be distinguished by its glabrous character, its more leafy and branching stems and its more narrow pods. It is more frequent with us than that species, growing in swampy places and along streams and the shores of lakes.

Cardamine purpurea (*Torr.*) *Britton*

Goat island. *C. S. Osborne*. Syracuse. *Miss Cobb*. Previously reported as *C. rhomboidea purpurea* Torr., but now raised to specific rank in the *Illustrated flora of the Northern states and Canada*.

Barbarea Barbarea (*L.*) *MacM.*

The yellow cress is quite common and has been reported as *B. vulgaris arcuata* Gray, but it is now raised to specific rank.

Brassica juncea (*L.*) *Cosson*

Fields and waste places. Common. The indian mustard closely resembles the Charlock or wild mustard, *B. arvensis*, from which it may be distinguished by its more glabrous character, its longer and more slender pedicels and its less prominently nerved pod.

Viola scabriuscula (*T. & G.*) *Schw.*

The smoothish yellow violet was originally described as a distinct species and in my opinion should never have been reduced to the rank of a mere variety of *Viola pubescens*. As such it has often been a source of perplexity to young botanists who could scarcely believe it to be a variety of that species. It is common in our state and is very constant in its characters. It occurs in some localities where *V. pubescens* is wanting.

Hypericum majus (*Gray*) *Britton*

Shore of Bowman pond. Sand Lake, Rensselaer county. August. The larger Canadian St Johnswort was formerly considered a variety of the Canadian St Johnswort, *Hypericum Canadense*, and was reported as such.

Euonymus Europaeus *L.*

Borders of woods and waste places. West Albany. June. This shrub has been introduced into this country from Europe, and occasionally escapes from cultivation. Its common name is spindle tree.

Acer nigrum *Mx.*

Cattaraugus, Seneca and Onondaga counties. The black sugar maple has generally been regarded as a variety of the sugar maple, but following the *Illustrated flora* we now give it specific recognition. I have not observed it in the eastern part of the state. The chief difference between the two trees is found in the character of the leaves.

Rubus Allegheniensis *Porter*

Common in hilly and mountainous districts of the state. Long considered a form of *Rubus villosus*, the high bush blackberry, but separated from it by Prof. Porter in 1890, as a variety bearing the name *R. villosus montanus*. In 1896 he raised it to specific rank,

giving it the name under which it is here reported. Its fruit constitutes its chief and most available distinguishing character. This is longer than broad, and has small drupelets and a peculiar rich spicy flavor which most people prefer to that of the fruit of the species from which this has been separated.

Rubus Baileyanus *Britton*

Bailey's blackberry has long been known to be an inhabitant of our state and has been reported under the name *Rubus villosus humifusus.*

Agrimonia mollis (*T. & G.*) *Britton*

Roadside. Sand Lake, Rensselaer county. September. The single fruiting specimen found does not fully correspond to the description of the species to which we have with some doubt referred it. The lower surface of the leaves is slightly pubescent and is sprinkled with minute shining glands.

Aronia nigra (*Willd.*) *Britton*

The black chokeberry was reported in *N. Y. state flora* by Dr Torrey under the name *Pyrus arbutifolia melanocarpa.* It is more frequent in the eastern and northern parts of the state than the red chokeberry, *Aronia arbutifolia.* A dwarf form scarcely more than a foot high is common about Lake Minnewaska. It grows from thin soil covering rocks.

Amelanchier rotundifolia (*Mx.*) *Roem.*

North Elba, Essex county. This species should be cautiously separated from the closely related low June berry, *A. spicata.* It is a larger shrub and has larger leaves and flowers, but the leaves of *A. spicata* are sometimes quite as round as those of *A. rotundifolia.*

The following table will indicate the prominent distinguishing characters of our five species of this genus.

Lower surface of the young leaves glabrous or but slightly pubescent 1
Lower surface of the young leaves conspicuously pubescent or woolly 3
1 Flowers more than 4 in a cluster 2

1 Flowers not more than 4 in a cluster............A. oligocarpa
2 Leaves finely serrate........................A. Canadensis
2 Leaves coarsely serrate......................A. rotundifolia
3 Shrub or small tree, 6 to 20 ft tall, top of ovary glabrous............................A. Botryapium
3 Small shrub, 1 to 4 ft tall, top of ovary woolly.........A. spicata

Crataegus macracantha *Lodd.*

The long spined thorn has been reported as *Crataegus coccinea macracantha.* Following the *Illustrated flora* it is here given specific rank. Specimens collected near New Paltz have some of the spines 4½ inches long.

Crataegus mollis (*T. & G.*) *Scheele*

Albany and Rensselaer counties. May and June. The soft pubescent young shoots, pedicels and lower surface of the young leaves specially distinguish this species from *C. coccinea* with which it was originally connected as a variety.

Galium tinctorium *L.*

In *N. Y. state flora* and in the *Manual* this plant stands as a variety of *Galium trifidum.* It has recently been restored to its original position as a distinct species. Our specimens are from Bethlehem, Albany county and Freeville, Tompkins county. July.

Galium palustre *L.*

Damp ground and ditches. Near Ticonderoga. June.

Solidago alpestris *W. & K.*

Open summits of the higher peaks of the Adirondack mountains. Reported as *Solidago Virgaurea alpina,* but now regarded as a good species. Specimens of *S. Virgaurea* have been collected at Pulpit rocks on the shore of Lake Placid.

Solidago uniligulata (*DC.*) *Porter*

Bergen swamp, Genesee county. Reported as *S. neglecta linoides* Gr.

Aster Schreberi *Nees.*

Bethlehem, Albany county. July.

Aster glomeratus (*Nees.*) *Bernh.*

Albany county and Rathboneville, Steuben county. This and the preceding aster have been taken to be forms of the large leaved aster, *A. macrophyllus*, but it is more satisfactory to separate these white rayed asters from the blue rayed forms, since they afford obvious characters by which such a separation may easily be made.

Betula pumila *L.*

Abundant in the large wooded swamp near Lake Bonaparte. In fruit in July. This is closely related to *B. glandulosa* and its young shoots or branches are sometimes slightly glandular, nevertheless its larger leaves more conspicuously reticulated, its thicker fertile aments with the middle lobe of their scales larger than the others and the more obovate outline of the seeds afford sufficient marks for distinguishing it. *B. glandulosa* occurs on the summit of Mt Marcy.

Salix balsamifera (*Hook.*) *Barratt*

Near the southeastern shore of Mirror lake and the south end of Lake Placid. May and June. The range attributed to this species in *Illustrated flora* is Labrador to Manitoba, south to Maine, Ontario and Minnesota. The station here recorded is probably as far south as the balsam willow extends.

Juncus secundus *Bv.*

Amagansett, Suffolk county and Blue Mountain lake, Hamilton county. Reported under the name *Juncus tenuis secundus* Engelm.

Juncus Torreyi *Coville*

Charlotte, Monroe county. July. *Rev. L. Holzer.* This is *Juncus nodosus megacephalus* Torr. in *New York state flora.*

Sparganium androcladum (*Engelm.*) *Morong*

Wet places, and margins of lakes and streams. Sand Lake. Formerly considered a variety of *Sparganium simplex.*

Carex xanthocarpa *Bicknell*

Roadsides, wet meadows and pastures. Albany, Rensselaer and Saratoga counties. Not rare, but formerly united with *C. vulpinoidea*, from which it may be distinguished by its long culm commonly exceeding the leaves and by its larger perigynia.

Carex brunnescens (*Pers.*) *Poir.*

Summits of the high peaks of the Adirondack mountains. July and August. Formerly considered a variety of *C. canescens*, but easily distinguished from it. It has several synonyms.

Carex festucacea *Willd.*

Columbia and Sullivan counties. June and July. In the *Manual* this is included under *C. straminea brevior*.

Carex Bicknellii *Britton*

Dry, sandy soil. Saratoga county. July.

Carex costellata *Britton*

Thin woods, clearings and copses. Rensselaer and Suffolk counties. July. This was formerly included with *C. virescens*, of which, in *New York state flora* it was considered a luxuriant state not even worthy of being called a variety.

Panicum boreale *Nash*

Along streams and in wet places. Outlet of Lake Hamilton, Adirondack mountains. July.

Panicum lanuginosum *Ell.*

Thin woods. Albany and Saratoga counties. July.

Elymus intermedius (*Vasey*) *Scrib. & Sm.*

North Greenbush, Rensselaer county; Riverhead, Suffolk county and Rathboneville, Steuben county. July.

Picea brevifolia *Pk.*

PLATE A

Swamps and marshes. Adirondack mountains, Schoharie and Wyoming counties. June.

This small spruce has hitherto been deemed a form of the common black spruce, but in my opinion it is worthy of specific distinction. It is smaller than that species and has smaller leaves, which are commonly glaucous and less curved, smaller cones and much smaller seeds. The seeds are about half as long as the seeds of the black spruce and the seedwing is also about half as long as the seedwing of that tree. The twigs are pubescent and the sterigmata are glabrous or slightly pubescent. The cones are oval and their scales are eroded on the edge. While immature they are wholly purple or green with a purple margin. The tree is scarcely more than 20 or 30 ft high, and bears cones when only 4 or 5 ft high. The cones are 8 to 12 lines long, the leaves 2 to 5 lines long, the seed about 1 line and its wing about 2 lines long.

It inhabits swamps and open bogs, bears its flowers in June and matures its fruit in September or October.

A small, half-prostrate, shrub-like spruce occurs on the exposed summits of the high peaks of the Adirondack mountains. Its leaves are short and glaucous and on this account it has been considered a variety of this species. For convenience of reference I have named it variety *semiprostrata*. It does not bear fruit and is probably a mere form due to the peculiar and unfavorable character of its place of growth.

Raphidostegium Jamesii *L. & J.*

Trunks of trees. Adirondack mountains. August. *Mrs E. G. Britton.*

Lepiota acerina *n. sp.*

Pileus convex, dry, floccose-squamulose, pale tawny or subalutaceous, brownish and subumbonate in the center; lamellae thin, close, free, pallid, pruinose when dry; stem equal, stuffed or hollow, floccose-squamulose below the obsolete ring, colored like the pileus; spores oblong or narrowly elliptic, very blunt or subtruncate at one end, .0003 to .00045 in. long, .00016 to .0002 broad.

Pileus 8 to 12 lines broad; stem 1 to 1.5 in. long, about 2 lines thick.

Prostrate mossy trunks of sugar maple, *Acer Saccharum.* North Elba, Essex county. August.

Clitocybe gilva *Pers.*

Under pine trees. Delmar, Albany county. September. In Sylloge different dimensions are assigned to the spores of this species according to the different authors quoted. In our specimens the spores are globose or nearly so and .00016 to .0002 in. in diameter. This agrees with the dimensions given by Professor Saccardo himself.

Clitocybe monadelpha *Morg.*

PLATE B, *fig.* 1-5.

Grassy places. Menands, Albany county. September. Edible. Resembling *Armillaria mellea*, but distinguished from it by the absence of a collar from the stem, by the more decidedly decurrent lamellae and by the solid stem. It is also more agreeable in flavor. It is related to *C. illudens* in habit and mode of growth.

Clitocybe fellea *n. sp.*

PLATE B, *fig.* 8-11.

Pileus thin, convex or hemispheric, obtuse or umbilicate, minutely furfuraceous, pale yellowish brown, flesh whitish, taste bitter; lamellae thin, subdistant, adnate or slightly decurrent, white; stem equal, firm, flexuous, glabrous, stuffed with a white pith, with a white mycelioid tomentum at the base; spores broadly elliptic, .00024 to .0003 in. long, .0002 broad.

Pileus 6 to 12 lines broad; stem about 1 in. long, 1 to 2 lines thick.

Growing in groups on the ground in woods. Gansevoort, Saratoga county. July.

The pale color, deep umbilicus and bitter taste are prominent characters. The species is referable to the tribe Versiformes.

Mycena cyaneobasis *n. sp.*

PLATE B, *fig.* 1-7.

Pileus thin, submembranaceous, conical or subcampanulate, at first brownish with the margin or apex or both tinged with blue, soon fading to grayish or dingy white, striate on the margin; lamellae close, adnexed, white; stem slender, firm but brittle, hollow, pruinose or subpulverulent, radicating, mycelium blue; spores sub-

globose, .00024 to .0003 in. long, nearly as broad, usually containing a single large nucleus.

Pileus 3 to 6 lines broad; stem 1.5 to 2.5 in. long, scarcely 1 line thick.

Decaying trunks of yellow birch, *Betula lutea.*

It is well marked by its radicating stem and blue mycelium. Its flavor at first resembles that of radishes, but this soon changes in the mouth to a bitterish unpleasant taste. The species is referable to the Rigidipedes. It differs from *Mycena calorhiza* Bres. in its firm stem, its pallescent pileus and broadly elliptic or subglobose spores.

Omphalia clavata *n. sp.*

Pileus thin, convex, becoming nearly plane, glabrous, pallid or subcinereous, the margin decurved; lamellae narrow, distant, very decurrent, pallid; stem long, slender, glabrous, stuffed, commonly enlarged at the top, slightly villous-tomentose at the base, pallid; spores globose, .0002 to .00024 in. broad.

Pileus 2 to 4 lines broad; stem about 1 in. long, 5 lines thick.

Dead prostrate trunks of arbor-vitae, *Thuja occidentalis.* Raybrook, Essex county. August.

The base of the stem is clothed with a few long loose whitish filaments, and the thickened upper part is often fluted by the long decurrent lamellae. The clavate form given to the stem by this enlargement is suggestive of the specific name.

Omphalia papillata *n. sp.*

Pileus membranaceous, conical or campanulate, nearly even, papillate at the apex, pure white; lamellae few, distant, arcuate and strongly decurrent, white; stem filiform, glabrous, white, attached to the matrix by a few radiating white filaments; spores broadly elliptic or subglobose, .00016 to .0002 in. long.

Pileus 1 to 3 lines broad; stem about 1 in. long, scarcely thicker than a thread.

Sticks and fallen leaves in woods. Gansevoort. July.

The species is related to *Omphalia Fibula.* It should also be cautiously separated from *Mycena immaculata.*

Marasmius ramulinus *n. sp.*

Pileus very thin, submembranaceous, broadly convex, nearly even when young, becoming irregularly plicate-striate or radiately wrinkled on the margin, subumbilicate or slightly depressed in the center, white; lamellae rather close, adnate, white; stem slender, inserted, minutely downy or pruinose, stuffed, whitish, becoming rufescent or pale tawny red; spores elliptic, .0003 in. long, .00012 to .00016 broad.

Pileus 2 to 4 lines broad; stem 6 to 9 lines long.

Dead twigs, branches and herbaceous stems. Delmar, Albany county. August.

Related to *Marasmius ramealis* and *M. candidus*. From the former it may be distinguished by its striate or wrinkled pileus and from the latter by its adnate closer lamellae. Its spores also are larger than in either of these.

Marasmius polyphyllus *n. sp.*

Pileus fleshy, thin, convex or nearly plane, even, varying in color from whitish to pale reddish, often reddish brown on the disk, odor and taste alliaceous; lamellae very numerous, narrow, crowded, adnexed or almost free, white; stem equal, hollow, reddish brown, clothed with a whitish down or tomentum which is commonly more abundant toward the base; spores minute, elliptic, .0002 to .00024 in. long, .00012 to .00016 broad.

Pileus 1 to 2 in. broad; stem 1.5 to 3 in. long, 1 to 3 lines thick.

Shaded damp ground. Minerva, Essex county. July.

Gregarious or sometimes caespitose. Occasionally specimens are found that exceed the dimensions given above. The peculiar garlic-like flavor remains in the mouth a long time after tasting the flesh. The species is referable to the tribe Tergini and is related to *M. prasiosmus*, from which it differs in its larger size, more crowded lamellae and smaller spores. The lamellae are whiter than those of *Collybia confluens* and nearly as crowded. Their great number has suggested the specific name. The downy coating of the stem is usually very thin at the top and sometimes absent there.

Marasmius vialis *n. sp.*

Pileus membranaceous, convex, pruinose, white; lamellae arcuate, distant, decurrent, white; stem short, tough, solid, at first white, then brown or blackish but covered with a white pruinosity, commonly swollen at the base into a small downy bulb.

Pileus 2 to 5 lines broad; stem 6 to 10 lines long, about .5 line thick.

Damp ground by roadside. Gansevoort, Saratoga county. July.

This fungus has almost the same style of coloration as *Marasmius nigripes*, from which it differs in its smaller size, distant decurrent lamellae, bulbous base of the solid stem and in its habitat.

Marasmius subnudus (*Ellis*) *Pk*

Pileus thin, flexible, tough, broadly convex or nearly plane, glabrous, more or less striate on the margin, often somewhat irregularly uneven, dull brownish red or dingy bay, taste of the dry plant bitter, unpleasant; lamellae narrow, subdistant, rounded behind, nearly free, whitish or creamy yellow, becoming darker in drying; stem slender, equal, tough, inserted, solid, reddish brown above, blackish brown below, everywhere clothed with a grayish down or tomentum which is commonly a little more dense near the base.

Pileus 10 to 20 lines broad; stem 1.5 to 3 in. long, 1 to 1.5 lines thick.

Fallen leaves and sticks in woods. July and August. Suffolk, Albany, Rensselaer and Essex counties. Common.

This is *M. peronatus subnudus* Ellis, no. 909, N. A. fungi. It differs so much in its characters and general appearance from the descriptions and figures of the European *M. peronatus*, that it seems to me to be worthy of specific distinction. The pileus is almost membranaceous, often wavy or irregular on the margin, never umbonate so far as I have seen, and more highly colored. The lamellae are not at all crowded, nor have I ever seen them rufescent. The stem is not sensibly narrowed upward and its color is darker than in *M. peronatus.* The tomentum on the lower part is by no means as copious and conspicuous as represented in the European plant. The

taste of the dried plant is bitter rather than acrid. The taste of the fresh plant has not been proved by me. The abrupt truncate or disk-like base of the stem is not shown in the figures of *M. peronatus.*

Clitopilus popinalis *Fr.*

Woods. Gansevoort. July. The whole plant is of a grayish color except the mature lamellae which have a flesh-colored hue, and the base of the stem which is clothed with a white tomentum. It has a farinaceous odor.

Leptonia subserrulata *n. sp.*

Pileus thin, convex or campanulate, umbilicate, obscurely striate on the margin, grayish white, darker colored and squamulose in the umbilicus; lamellae thin, close, adnate, white at first, bluish black and minutely denticulate on the edge; stem slender, rather long, hollow, glabrous, whitish or pallid; spores irregular or angular; .0004 to .00045 in. long, .0003 broad, usually containing a single large nucleus.

Pileus 8 to 15 lines broad; stem 2 to 3 in. long, about 1 line thick.

Low damp ground in woods. Gansevoort. July.

This species is closely allied to *Leptonia serrulata,* but differs from it in its paler and more campanulate pileus, its paler lamellae and paler glabrous stem which is wholly destitute of dots or punctate markings at the top.

Pholiota lutea *n. sp.*

Pileus fleshy, firm, convex, dry, slightly silky, sometimes minutely floccose-squamulose toward the center, buff yellow, often a little darker at the center, the thin incurved margin slightly surpassing the lamellae, flesh pale yellow, odor pleasant, taste bitter; lamellae thin, close, rounded behind, adnexed, pale yellow, becoming dark ferruginous with age; stem firm, solid, thickened at the base, fibrillose, colored like the pileus, annulus slight, usually near the top of the stem; spores elliptic, ferruginous, .0003 in. long, .0002 broad.

Pileus 2 to 4 in. broad; stem 2 to 3 in. long, 3 to 5 lines thick.

Decaying wood and trunks of trees in woods. August.

Allied to *Pholiota spectabilis* and *P. villosus,* but distinguished from

the former by the adnexed lamellae and from the latter by its smoother pileus and solid stem. The pileus is silky rather than villous.

Pholiota marginella *n. sp.*

PLATE B, *fig.* 12-20.

Pileus fleshy, convex becoming nearly plane, glabrous, hygrophanous, yellowish red or subferruginous when young or moist, then commonly striatulate on the margin, yellowish buff or whitish when dry, the young margin slightly silky with the whitish fibrils of the veil; lamellae close, thin, adnexed, minutely eroded on the edge, whitish, becoming dark ferruginous; stem flexuous, subequal, fibrillose, pruinose or mealy above the slight evanescent annulus, stuffed or hollow, pallid or whitish, sometimes with a white mycelioid tomentum at the base; spores elliptic, .00024 to .0003 in. long, .00016 to .0002 broad.

Pileus 1 to 2 in. broad; stem 2 to 4 in. long, 2 to 4 lines thick.

Single or caespitose on decaying wood. North Elba. June.

The species is related to *P. marginata*, from which it differs in its paler color, even or merely striatulate margin, adnexed lamellae and uniformly colored stem. In drying the moisture first disappears from the center of the pileus.

Inocybe rigidipes *n. sp.*

Pileus thin, convex or subcampanulate, becoming expanded, umbonate, squamulose, striate on the margin when dry, tawny gray; lamellae broad, subdistant, narrowed behind, slightly adnexed, tawny ochraceous, commonly whitish on the edge; stem rather slender, flexuous, rigid, firm, solid, slightly pruinose, colored like the pileus; spores globose, echinate, .0005 in. broad.

Pileus 6 to 12 lines broad; stem 1.5 to 2.5 in. long, about 1 line thick.

Damp clayey ground in shaded places. Menands, Albany county. August.

When dried specimens are soaked in water the shriveled stems recover the plump condition of the fresh state. The spores are similar to those of *Inocybe calospora*, but they are a little larger. The

squamules of the pileus are not appressed, nor has the pileus the same color as that species.

Inocybe albodisca *n. sp.*

Pileus conical or campanulate, umbonate, smooth and whitish at the apex when fresh and moist, elsewhere dingy, yellowish brown or lilac brown, paler when dry and slightly fibrillose or silky, longitudinally rimose; lamellae moderately close, rounded behind, whitish when young, becoming subferruginous with age; stem equal, solid, striate, glabrous or slightly mealy or pruinose at the top, pallid; spores nodulose, .0003 in. long, nearly as broad.

Pileus about 1 in. broad; stem 1 to 2 in. long, 2 to 3 lines thick.

Under spruce and balsam fir trees. North Elba, Essex county. August.

Easily distinguished from all other species of this genus known to me, by the whitish umbonate apex of the pileus.

Flammula viscida *n. sp.*

Densely caespitose; pileus hemispheric or convex, glabrous, covered with a separable viscid pellicle, obscurely striatulate on the margin when moist, pale yellow, the thin margin incurved when young, flesh white; lamellae thin, close, emarginate, adnexed, whitish when young, becoming dark ferruginous; stem equal, fibrous, hollow but the cavity small, sometimes squamulose, pallid or subferruginous; spores brownish ferruginous, broadly elliptic, .00024 to .0003 in. long, .00016 to .0002 broad.

Pileus 6 to 12 lines broad; stem 1 to 2 in. long, 1.5 to 2 lines thick.

Decaying wood of alder, *Alnus incana*. North Elba. August.

This species resembles *F. alnicola* in color, but its smaller size, densely caespitose mode of growth, viscid separable pellicle and emarginate lamellae separate it. Sometimes there is a slight trace of an annulus on the stem, thereby indicating a close relationship to the genus Pholiota.

Tubaria deformata *n. sp.*

Pileus thin, convex, becoming plane or centrally depressed, often wavy or irregular on the margin, glabrous, hygrophanous, reddish

brown when moist, whitish when dry; lamellae thin, close, wider behind, adnate or decurrent, often wavy, branched or even anastomosing, brownish ferruginous; stem firm, hollow, tapering downward, clothed with grayish white fibrils; spores broadly elliptic, .0003 in. long, .00024 broad.

Pileus 6 to 12 lines broad; stem 1 to 2 in. long, 1 to 2 lines thick.

Dung in old roads in woods. Connery pond, North Elba. August.

The irregular character of the pileus and lamellae give this plant a deformed appearance.

Deconica semistriata *n. sp.*

Pileus thin except on the prominent broadly umbonate disk, glabrous, somewhat wavy on the margin and striate to the umbo, grayish brown, paler when dry and less distinctly striate, the broad umbo yellowish; lamellae broad, distant or subdistant, adnate or slightly decurrent, purplish brown, whitish on the edge; stem equal, firm, short, slightly floccose-fibrillose, stuffed with a whitish pith, colored like the pileus; spores compressed, suborbicular, .00025 to .0003 in. long, .00025 broad.

Pileus 4 to 5 lines broad; stem 8 to 10 lines long, .5 line thick.

Damp ground in woods. Gansevoort. July.

Easily distinguished by the broad convex umbo-like disk and the widely striate margin.

Gomphidius vinicolor *n. sp.*

Pileus thick, fleshy, convex or nearly plane, viscid, dark red, becoming blackish in drying; lamellae distant, decurrent, olive brown or blackish when mature; stem subequal, glabrous, solid, vinous red, paler within; spores oblong-fusiform, .0007 to .0008 in. long, .00024 to .0003 broad.

Pileus 1 to 2.5 in. broad; stem 1.5 to 2.5 in. long, 2 to 4 lines thick.

Under pine trees. Lake Mohonk. October.

This species is closely related to *Gomphidius roseus*, from which it differs in the color of the stem, lamellae and flesh. The gluten of the pileus becomes blackish in drying and sometimes separates in a radiating manner, revealing the reddish color of the surface of the

pileus. The mature lamellae appear velvety when viewed by the aid of a lens. This is due to the abundance of the prominent spores that cover their surfaces.

Hygrophorus immutabilis *n. sp.*

Pileus thin, conical or convex and umbonate, often striate when dry, greenish brown or yellowish brown, not changing color in drying; lamellae subdistant, whitish or yellowish; stem slender, glabrous, hollow, yellow; spores elliptic, .0004 to .0005 in. long, .00024 to .00028 broad.

Pileus 8 to 12 lines broad; stem 1 to 2 in. long, 1.5 to 2 lines thick.

Dryish sandy or heathy places. Raybrook, Essex county. August.

This plant is manifestly closely allied to *Hygrophorus conicus*, and might easily be considered a mere variety of it. It differs, however, in being less regularly and acutely conical, in having no orange, scarlet or red hues, in its paler or whitish lamellae and specially in its unchangeable color. Specimens of *H. conicus* collected at the same time and place and subjected to the same method of drying turned black, as usual, but these retained their colors.

Clavaria fellea *n. sp.*

Clubs about 1 inch high, ochraceous yellow, sparsely and subdichotomously branched; stem terete, solid; branches crowded, nearly parallel, the tips obtuse, concolorous; spores globose, .00024 in. broad; mycelium white.

Under oak trees. Gansevoort. July. Related to *C. muscoides*. The flavor is bitter and slightly farinaceous.

Boletus nebulosus *n. sp.*

Pileus convex, dry, snuff brown or smoky brown, flesh white, unchangeable; tubes convex, depressed around the stem, pallid or brownish, becoming purplish brown where wounded, the mouths small, rotund; stem enlarged toward the base, solid, scurfy, colored like the pileus; spores .0005 to .0006 in. long, .00024 broad.

Pileus 2 to 4 in. broad; stem 3 to 4 in. long, 4 to 6 lines thick. Shaded banks by roadside. Raybrook. August.

No young or immature specimens were seen and the description is to that extent incomplete.

Poria setigera *n. sp.*

Effused, tough, thin, adnate, the thin sterile byssine or tomentose margin whitish; pores minute, rotund, shallow, $\frac{1}{6}$ to $\frac{1}{7}$ line wide, smoky brown, suffused with a grayish white pruinosity, the dissepiments entire, their edges and the sterile margin bearing smooth colored setae .003 to .005 in. long, .0005 to .0006 broad.

Bark of red maple, *Acer rubrum*. Gansevoort. July.

This fungus forms patches by confluence several inches in extent. The setae are external and do not appear to develop within the pores. Therefore the species is not a Mucronoporus.

Trametes serialis *Fr.*

Decaying wood of spruce. Adirondack mountains. September.

Trametes serialis resupinata *Romell*

Resupinate, tough, adnate, white, 1 to 2 lines thick, composed mostly of the small equal round white pores, one eighth to one fifth line broad, the dissepiments obtuse, sometimes becoming subacute and dentate with age; subiculum thin, sterile margin at length almost wanting.

Wood and bark of spruce. Adirondack mountains.

This fungus usually forms continuous patches several inches in extent. On even decorticated surfaces it is generally even and regular in outline, but on uneven surfaces it is apt to be interrupted and irregular. It is allied to *Trametes serpens* but may be separated from it by its smaller and more regular pores and more obtuse dissepiments.

Hydnum chrysocomum *Underw.*

Much decayed sticks. New Dorp, Richmond county. October. *L. M. Underwood.*

Cyphella fasciculata *B. & C.*

Dead branches of alder, *Alnus incana.* Lake Pleasant and Boreas river, Adirondack mountains. July.

To the naked eye the clusters of cups appear to be grayish and pulverulent. In the typical form they are said to be pallid and minutely tomentose. The spores in our specimens are subglobose, .0002 to .00025 in. broad.

Geaster velutinus *Atk.*

New Russia, Essex county. *Mrs L. A. Millington.*

Catastoma circumscissum *(B. & C.) Morg.*

Trout lake, St Lawrence county. *Mrs E. C. Anthony.*

Lycoperdon cepiforme *Bull.*

Ground. Lake Mohonk. October.

Isaria penicilliformis *n. sp.*

Stems commonly tufted and united at the base, 4 to 6 lines high, simple or sparingly divided above, pointed or occasionally obtuse at the apex, everywhere flocculent-pulverulent, whitish, becoming glaucous green; spores terminal on protruding penicillately tufted filaments, subglobose, hyaline, .00012 to .00016 in. broad.

On starch paste. Jamaica, Queens county. January. *F. C. Stewart.*

It is possible that this fungus may be an extraordinary development of the common *Penicillium glaucum,* having the hyphae greatly elongated and compacted into a vertical stem from all sides of which their free ends project in penicillate clusters.

Cercospora caricina *E. & D.*

Living leaves of *Carex arctata.* North Elba. August.

Exoascus Insititiae *Sadeb.*

Living leaves of wild red cherry, *Prunus Pennsylvanica.* North Elba. June.

Exoascus unilateralis *n. sp.*

Spots mostly suborbicular, convex above, concave below, sometimes confluent and irregular, discolored, either paler or darker than the surrounding tissues; asci epiphyllous, subcylindric, sometimes a little contracted just above the basal cell, .0016 to .002 in. long, .0005 to .0006 broad, the stalk cell .0005 to .0006 in. broad and nearly as long; spores commonly 8, globose or broadly elliptic, .00024 to .0003 in. long, .0002 to .00024 broad.

Living leaves of choke cherry, *Prunus Virginiana*. Evans Mills, Jefferson county and North Elba, Essex county. June.

This species is allied to *Exoascus deformans*, from which it may be distinguished by its rather larger asci and spores and by its general habit. The invaded leaves are less distorted, even when the spots are large and occupy much of their surface, and the fungus, so far as I have seen, occupies the upper surface only. This at length becomes slightly whitened by the effusion of the spores. Generally there are from one to three spots on a leaf.

Hypocrea aurantiaca *n. sp.*

Perithecia minute, compactly crowded forming a continuous stratum or rarely scattered and involved in an orange colored tomentum, orange colored, the ostiola slightly darker; asci slender, cylindric, .0025 to .003 in. long, .00016 broad; spore cells subglobose, .00012 broad.

On *Polyporus chioneus*. Gansevoort. July.

This fungus appears to have been included by Mr Ellis in *Hypocrea pallida*, with which it agrees in spore characters, but from which it differs so greatly in its formation of a continuous crust and in the orange color of the perithecia and tomentum that it seems to me to merit separation as a distinct species.

Peziza odorata *Pk.*

Damp ground. Gansevoort and North Elba. July and August.

Sphaerella Cypripedii *n. sp.*

Spots large, 4 to 10 lines broad and long, brown reddish brown or grayish, sometimes with a darker border; perithecia minute, numerous, amphigenous, at first covered, then erumpent, punctiform, shining, black; asci subcylindric, .002 to .0024 in. long; spores crowded, oblong-fusiform, obscurely uniseptate, quadrinucleate, hyaline, .0006 in. long, .00016 to .0002 broad.

Living leaves of some exotic species of Cypripedium. Bay Ridge, Kings county. October. *Stewart.*

The spots usually occur at or near the apical extremity of the leaf.

D

REMARKS AND OBSERVATIONS

Brassica arvensis (*L.*) *B. S. P.*

The form introduced and naturalized in this country is described as having glabrous pods. Nevertheless a form having the pods hispid with stiff hairs pointing downward was collected in a vacant lot in Albany.

Roripa sylvestris (*L.*) *Bess.*

Banks of the Wallkill at New Paltz. May. The yellow cress or creeping yellow water-cress is an introduced plant, but it appears to be well established in this locality. It is *Nasturtium sylvestre* in the *Manual.*

Viola striata *Ait.*

Near Syracuse. *Mrs Goodrich.* The striped violet is not found in the eastern part of the state though its occurrence in the western part of New England has been recorded.

Viola primulaefolia *L.*

The primrose-leaved violet is rare with us. It occurs at Lake Minnewaska.

Acer Negundo *L.*

The box elder or ash-leaved maple has been reported as occurring in a swamp about seven miles west of Salamanca and near Red House Station.

Ilex monticola *A. Gray.*

This interesting shrub is not rare about Lake Minnewaska. It also occurs at Lake Mohonk. It blossoms in June in these localities. It has been reported from Cattaraugus county and from the Catskill mountains.

Solidago rugosa *Mill.*

A peculiar form of this species was found growing near Lake Ampersand. The flowering branches are very short, generally less than an inch long and shorter than the leaves in whose axils they grow. They therefore form an elongated narrow racemose leafy panicle.

Solidago neglecta *T. & G*

Rosecrans swamp near Glens Falls. August and September. *S. H. Burnham.*

Rhodora Canadensis *L.*

Shawangunk mountain. Abundant near Lake Minnewaska. May. This small shrub is a beautiful sight when in blossom. The flowers precede the leaves, and though smaller, they are similar in color to and scarcely less showy than those of the pinkster-flower, *Azalea nudiflora.* They assume a purplish hue in drying. A single flowering specimen was collected several years ago near Thirteenth pond in Warren county and contributed to the herbarium by Mrs I. B. Sampson. Aside from this, the localities on the Shawangunk mountain are the only places in the state from which specimens have come to my notice.

Plantago major *L.*

A small pubescent form is not rare along streams and about the margins of lakes in the Adirondack region. The leaf blades are 1 to 2 inches long and the scapes are 2 to 4 high. The number of seeds in each seed vessel is often less than eight.

Arisaema triphyllum pusillum *n. var.*

Plants 3 to 6 inches high; leaves usually solitary, the leaflets narrowed and pointed at the base, 12 to 18 lines long, 7 to 9 wide; the upper part of the spathe commonly dark purple.

Millbrook, Dutchess county. June. *Fred. Thorne.*

The plants were in flower June 15th, about a month later than the time of flowering of the typical form of the species in the same locality.

Tetraplodon mnioides *L. f.*

Specimens of this rare moss were collected many years ago on the Catskill mountains by the late S. T. Olney. A sample of these specimens has been presented to the state herbarium by *Mrs E. G. Britton.*

Lepiota arenicola *Pk.*

This plant was discovered and published 10 years ago. It was found the second time in July of the present year, growing in sandy soil near Gansevoort. These are fine specimens a little larger than the typical form. The species is apparently rare.

Lactarius aquifluus brevissimus *n. var.*

Pileus 1 to 1.5 in. broad, grayish buff; lemellae crowded, adnate, yellowish or cream color; stem very short, 6 to 8 lines long.

Black mucky soil in roads in woods. Township 24, Franklin county. September.

Plant fragrant; sometimes caespitose.

Cantharellus brevipes *Pk.*

Woods. North Elba. August. It sometimes grows in arcs of circles. This species is very rare. It was found 18 years ago, and since that time had not been seen by me till this summer. It has recently been found in Vermont also.

Boletus chrysenteron *Fr.*

The variability of this species is quite perplexing. Two forms occur near Gansevoort. In one the young pileus is red but it fades with age to a grayish buff. It has a persistently red and minutely scurfy stem. In the other the pileus is dark brown or olivaceous and the stem is pale red or yellow and red. In both, the flesh may be either yellow or whitish and the cracks in the pileus may be either red or pallid. In both, wounds assume a blue color. The flesh is sometimes whitish above and yellow next the tubes.

Polyporus umbellatus *Fr.*

Prof. Atkinson finds this rare species near Ithaca.

Polyporus Anax *Berk.*

This species has apparently been confused by some American mycologists with *Polyporus intybaceus.* I have received specimens of it bearing that name. The spores of that species are described as elliptic or ovoid. The spores of *Polyporus Anax,* as shown by our specimens, are globose.

Poria aurea *Pk.*

Pine wood near Ithaca. *Atkinson.* The typical specimens were found eight years ago, growing on decaying wood of sugar maple. No others except the Ithaca specimens have come to my notice and the species is apparently very rare.

Gyromitra esculenta crispa *n. var.*

Whole surface of the pileus finely reticulate with anastomosing costae.

Under evergreens. North Elba. June.

Gyromitra sphaerospora (*Pk.*) *Sacc.*

PLATE B, *fig.* 21-25.

Two specimens of this fungus were found in the Adirondack region 24 years ago. Since then a single specimen was sent me by Prof. Dudley who found it near Ithaca. In June a fine large cluster of this extremely rare fungus was found growing on decaying wood by the side of the Adirondack Lodge road. Some of the specimens had the pileus 4 or 5 in. broad, and the stem 3 or 4 in. long and 1 to 2 in. thick. The stem in the large specimens is deeply grooved and often pinkish tinted at the base, but it loses this color in drying. The plants emit a strong unpleasant odor in drying. The species is well marked by its globose spores and so far as I know has not yet been found beyond the limits of our state.

Helvella elastica albida (*Pers.*) *Sacc.*

Near Gouverneur, St Lawrence county. June. *Mrs Anthony.*

Spathularia rugosa *Pk.*

North Elba. August. This is the second time this rare plant has been found. It was growing in lines or arcs of circles.

E

EDIBLE FUNGI

Amanitopsis strangulata (*Fr.*) *Roze*

STRANGULATED AMANITOPSIS

PLATE 50, *fig.* 1-10.

Pileus fleshy but rather thin, fragile, at first ovate, then broadly convex or subcampanulate, finally nearly plane, warty, slightly viscid when moist, deeply and distinctly striate on the margin, grayish brown or mouse color, sometimes paler on the margin; lamellae close, free, broader toward the outer extremity, white or whitish; stem equal or slightly tapering upward, stuffed or hollow, floccose-squamulose, white or whitish, the adherent remains of the ruptured volva sometimes forming an imperfect or fragmentary annulus near the base; spores globose, .0004 to .0005 in. in diameter.

The strangulated Amanitopsis resembles the livid variety of the sheathed Amanitopsis in color and size, but it is easily distinguished by the warts of the pileus and by the fragmentary remains of the ruptured volva or wrapper at the base of the stem. The spores also are a little larger than in that species.

When the young plant first appears above the surface of the ground, the cap is oval or somewhat egg-shape, but it soon becomes more expanded and finally nearly flat. In wet weather the margin sometimes curves upward making the cap appear concave above or centrally depressed. The warts have a soft or somewhat woolly texture and are easily separable from the cap. In the European plant they are represented as sometimes entirely absent. In the American plant they are quite persistent on the center of the cap, though they sometimes disappear from the thin plicate-striate margin. They are represented in the figure of the species given by Fries in his *Icones* as paler than the cap, but in our plant they are as

dark as the cap or sometimes even darker. The cap is grayish brown or mouse color, sometimes becoming paler or drab on the margin.

The gills are white or whitish, free from the stem and broader as they approach the margin of the cap. The intervening short ones are truncated at the inner extremity.

The stem is neither bulbous nor distinctly annulate. It is white or whitish and more or less mealy or scurfy. It is rather slender and sometimes slightly tapering upward. Near the base it is often adorned with a few transverse fragments of the wrapper which are often so arranged as to resemble an incomplete ring or collar. Occasionally two or even three of these imperfect collars are formed. Fries represents the base of the stem of the European plant as sheathed by a membranaceous wrapper, but such a character is not well shown in the American plant. Neither does it show the one or two swollen nodes near the base of the stem, as represented in the figure in *Icones*. I suspect these discrepancies are due to the failure of the artist to represent these characters accurately, for Berkeley's figure of *Agaricus Ceciliae* B. & Br., which Fries, in *Hymenomycetes Europaei*, places as a synonym of *Agaricus strangulatus*, well represents our plant. It is also well represented in the figure of *Agaricus strangulatus* as given by Saunders and Smith. They also represent the spores as globose, but at the same time they quote the presumably incorrect description of them, which says that they are oval, .0006 inch long, .00034 broad. Saccardo has also admitted this description of the spores in Sylloge. We must either suppose this description is incorrect or else we must suppose that all recent mycological authors, including the illustrious Fries himself, have confused two distinct species. The former supposition seems to us to be the more reasonable. If, however, it should ever be shown that *Agaricus Ceciliae* B. & Br. is not the same as *Agaricus strangulatus* Fr., then our American plant must bear the name *Amanitopsis Ceciliae* (B. & Br.) instead of the name we have used.

The cap is 1½ to 4 in. broad, the stem is 3 to 5 in. long and 3 to 6 lines thick.

The plants grow in groups in or near the borders of woods. They appear in July. The species is rare with us. It was first found by me in 1869, near Greenport, Suffolk county. The second locality known to me is near Gansevoort, Saratoga county, where it was recently found growing in a field but near the borders of some woods. Its edible character was tested and it was found to be agreeable and harmless but not highly flavored. It is much like the sheathed Amanitopsis in this respect. European authors do not appear to have included it among the edible species.

Clitocybe monadelpha *Morg.*

CLUSTERED CLITOCYBE

PLATE 51, *fig.* 1-5.

Pileus fleshy, convex becoming nearly plane or somewhat depressed, at first glabrous or nearly so, then squamulose or virgate, variable in color, honey-color, pale reddish brown or reddish, the margin even, flesh white or whitish; lamellae moderately close, distinctly decurrent, whitish or pale flesh color; stem long, solid, crooked, fibrous, tapering at the base, shining, pallid or brown; spores subelliptic, .0003 in. long, .0002 broad.

The clustered Clitocybe is a rare species in our state and has been found by me in one locality only. It is apparently more plentiful farther west. It resembles the honey-colored armillaria in size and general appearance, but it may be distinguished by the entire absence of a veil and a collar, by its decidedly decurrent gills and by its solid stem. The cap in the typical western form is at first smooth but it finally becomes scaly. In the eastern form it is smooth or nearly so when young, but it is soon adorned with minute tufted fibrils or fibrillose scales in the center and with darker lines or closely pressed fibrils toward the even margin. The color in our specimens is a pale reddish brown, a little darker than isabelline and approaching russet. The western form varies from honey-color to reddish brown. The gills are whitish or pallid and they run down on the stem, gradually tapering to a point. The stems are densely clustered and united at the base, forming tufts of many individuals. They are more or less irregular, twisted, crooked and tapering

toward the base. They have a fibrous texture externally and are smooth and somewhat shining. In our specimens they are brown and darker than the cap.

The cap is 1 to 2½ in. broad, the stem is 3 to 4 in. long and 2 to 4 lines thick.

The plants grow under trees and appear in September. In Ohio the typical form is said to grow from spring till late autumn and to form clusters of 20 to 50 individuals.

The flavor seems to me to be superior to that of the honey-colored armillaria.

Hygrophorus flavodiscus *Frost*

YELLOW-DISKED HYGROPHORUS

PLATE 51, *fig.* 6-11.

Pileus fleshy, convex or nearly plane, glabrous, very viscid or glutinous, white, pale yellow or reddish yellow in the center, flesh white; lamellae adnate or decurrent, subdistant, white, sometimes with a slight flesh-colored tint, the interspaces sometimes venose; stem subequal, solid, very viscid or glutinous, white at the top, white or yellowish elsewhere; spores elliptic, white, .00025 to .0003 in. long, .00016 to .0002 broad.

The yellow-disked Hygrophorous scarcely differs from the sooty Hygrophorous in any respect except in color. It is sometimes found growing with it in pine woods. Both appear late in autumn. The cap is rather thick and fleshy in the center but thin at the margin. It is so very viscid or glutinous that when dry its surface is smooth and shining as if varnished. The color of the disk is yellowish or reddish yellow but the margin is white.

The interspaces between the gills are distinct and sometimes are marked by cross veins. The gills are white or nearly white and are attached to the stem or run down upon it.

The stem is solid and externally glutinous except a short space at the top.

The cap is 1 to 3 in. broad, the stem 1 to 3 in. long and from ¼ to ½ an in. or more thick.

The flesh is tender and well flavored and the species may well be placed in the list of first-class mushrooms. In consequence of the slimy surface, the cap is apt to be soiled by adhering dirt and leaves and it should be peeled before cooking.

There is a closely related European species, *Hygrophorus Friesii*, which scarcely differs from this mushroom except in having the whole cap uniformly pale yellow and in its gills becoming pallid with age. It has not yet been found in our country.

Collybia radicata *Relh.*

ROOTED COLLYBIA

PLATE 52

Pileus thin, convex or nearly plane, glabrous, viscid when moist, grayish brown or smoky brown, flesh white; lamellae broad, subdistant, adnexed; stem long, slender, firm, generally slightly tapering upward, stuffed, colored like or a little paler than the pileus, ending below in a long root-like prolongation which penetrates the earth deeply; spores elliptic, with a slight oblique apiculus at one end, .0006 to .0007 in. long, .0004 to .0005 broad.

The rooted Collybia is a common species and one easily recognized if notice is taken of the lower part of the stem. This is like a long slender tap root, tapering downward and generally penetrating the earth to a depth about equal to the length of the stem above the surface.

The cap is broadly convex or nearly flat, and sometimes is slightly raised or umbonate in the center. In well developed specimens the central part is generally rugose or radiately wrinkled. In wet weather it is viscid or even glutinous, but in dry weather the viscidity is scarcely noticeable. Notwithstanding this tendency to viscidity the cap is usually clean and attractive.

The gills are broad, thick, well separated from each other and excavated or notched at the end next the stem. The point of attachment is therefore much more narrow than the middle part of the gill. The gills are white or slightly tinged with yellow.

The stem is generally thickest at the surface of the ground and tapers slightly from this point in both directions. In the typical

form it is smooth, but a variety is common in which it is minutely scurfy. This is named variety *furfuracea*. There is also a small form, called variety *pusilla*, in which the cap is about 1 in. broad. All these have the root-like prolongation of the stem which is suggestive of the specific name. The color of the stem is either whitish or similar to the color of the cap but paler. In the scurfy-stemmed variety it is often darker colored than in the typical form. Specimens are sometimes found in which the stem is white and occasionally both cap and stem are white. The spores are white when fresh, but after long exposure they sometimes assume a yellowish color.

The cap is from 1 to 4 in. broad and the stem from 2 to 8 in. long above the surface of the ground, and from 2 to 3 or rarely 4 lines thick.

In one specimen in the state herbarium the subterranean or root-like prolongation of the stem is a little more than 10 in. long. The plants grow singly or sparsely scattered in woods or recent clearings and may be found from June to October. The caps are somewhat tough but agreeable in flavor and the species is classed as an edible one without any hesitation.

Collybia velutipes *Curt.*

VELVET-STEMMED COLLYBIA

PLATE 50, *fig.* 11-16.

Pileus rather thin, convex or nearly plane, obtuse, glabrous, viscid, reddish yellow or tawny; lamellae broad, subdistant, rounded behind, slightly adnexed, white or tinged with yellow; stem firm, externally cartilaginous, stuffed or hollow, brown or tawny brown, velvety hairy when mature; spores narrowly elliptic, .0003 to .00036 in. long, .00016 broad.

The velvet-stemmed Collybia is one of the few mushrooms that appear very late in the season. It may be found after nearly all others have yielded to the severity of the weather. It has even been called a winter mushroom because it is possible to find it in prolonged mild thawing weather in winter. It sometimes develops in spring also. It is easily recognized by its viscid tawny cap, its velvety stem and tufted mode of growth. Sometimes the cap is

wholly yellowish or yellowish on the margin and darker on the central part. Because of the crowded mode of growth the caps are sometimes very irregular. The gills are rounded or deeply notched next the stem so that they are slightly attached to it. They are whitish or white tinged with yellow. In very young plants the stem is whitish, but it soon becomes tawny or tawny brown from the development of the dense coat of velvety hairs. It is generally hollow.

The caps are generally about 1 inch broad in large tufts, but in smaller and looser clusters or in scattered or single growths they are often larger. The stems vary from 1 to 3 or 4 in. long and from 1 to 3 lines thick. The plants grow on dead trunks of trees either standing or prostrate or on old stumps or decaying wood.

Its edible qualities are not inferior to those of the preceding species. Its flesh is more tender and quite as agreeable in flavor. It is well to peel the caps before cooking in order to free them from adhering particles of dirt or other objectionable matter.

Russula roseipes (*Secr.*) *Bres.*

ROSY-STEMMED RUSSULA

PLATE 53, *fig.* 1-7.

Pileus convex becoming nearly plane or slightly depressed, at first viscid, soon dry, becoming slightly striate on the thin margin, rosy red variously modified by pink orange or ochraceous hues, sometimes becoming paler with age, taste mild; lamellae moderately close, nearly entire, rounded behind and slightly adnexed, ventricose, whitish becoming yellow; stem slightly tapering upward, stuffed or somewhat cavernous, white tinged with red; spores yellow, globose or subglobose.

The rosy-stemmed Russula is a good example of the close relation that exists between some species of this genus, and of the difficulty of assigning satisfactory limits to species. This Russula was first described by Secretan who considered it a variety of *Russula alutacea* and named it *Russula alutacea roseipes.* It was afterward raised to specific rank by Bresadola and was accepted as a good species by Saccardo in *Sylloge.* Still later it was reduced again to varietal rank

by Massee who considered it a variety of *Russula puellaris* and named it *Russula puellaris rosecipes*. Though having points of resemblance to both *R. alutacea* and *R. puellaris* it seems better to us to retain it as a distinct species. It is not common in our state, having been collected in Albany and Saratoga counties only. Its distinguishing characters are its mild taste, its rosy cap which is commonly dry and but slightly striate on the margin, its gills changing from whitish to yellow or subochraceous and being slightly attached to the stem and its stem being slightly stained with rosy red.

From *R. alutacea* it may be separated by its smaller size, more narrow and slightly attached gills and by its less highly colored gills and spores. From *R. puellaris*, which it resembles in size, it may be distinguished by not having the center of the cap more highly colored than the rest and by the rosy tint of the stem. In the European plant the stem is said to be sprinkled with a rosy mealiness or pruinosity, but in our plant the color appears to be in the stem itself.

The cap is 1 to 2 in. broad, the stem is 1½ to 2 in. long and 3 to 4 lines thick. The plants grow in woods of pine and hemlock and have been collected in July and August. The flesh is tender and agreeable in flavor.

Russula ochrophylla *Pk.*

Ochery-gilled Russula

Plate 53, *fig.* 8-14.

Pileus firm, convex becoming nearly plane or slightly depressed in the center, even or rarely very slightly striate on the margin when old, purple or dark purplish red, flesh white, purplish under the adnate cuticle, taste mild; lamellae entire, a few of them forked at the base, subdistant, adnate, at first yellowish, becoming bright ochraceous buff when mature, dusted by the spores, the interspaces somewhat venose; stem equal or nearly so, solid or spongy within, reddish or rosy tinted, paler than the pileus; spores bright ochraceous buff, globose, verruculose, .0004 in. broad.

The ochery-gilled Russula is a large fine species but not a common one. It differs but little in color and size from the European pun-

gent Russula, *Russula drimeia,* but it is easily distinguished from it by its mild taste.

The cap is dry, 2 to 4 in. broad, convex or a little depressed in the center, purple or purplish red, the white flesh purplish under the cuticle, which, however, is not easily separable.

The gills are nearly all entire, extending from the stem to the margin of the cap. They are therefore much closer together near the stem than at the margin. They are at first yellowish, but a bright ochraceous buff when mature. They are then dusted by the similarly colored spores.

The stem is stout, nearly cylindric, firm but spongy in the center and colored like the cap but generally a little paler. There is a variety in which the stem is white and the cap deep red. In other respects it is like the typical form. Its name is *Russula ochrophylla albipes.*

This mushroom has an agreeable flavor but the flesh is rather firm. Unless peeled before cooking it imparts a purplish hue to the milk or other liquid in which it is stewed. Its edible qualities appear to me to be similar to those of the greenish Russula, *Russula virescens.* Both are fairly good but neither seems to be highly flavored. No mild-flavored Russula is known to be deleterious and two or three of my correspondents claim that even the very acrid *Russula emetica* loses its acridity in cooking and has been eaten by them without any harm. But there are so many mild species that there is no need of running any risks by eating the acrid ones. The ochery-gilled Russula grows in groups under trees, especially oak trees, and should be sought in July and August.

Boletus subglabripes *Pk.*

Smoothish-stemmed Boletus

Plate 55

Pileus convex or nearly plane, glabrous, reddish inclining to chestnut color, flesh white, unchangeable; tubes adnate, nearly plane in the mass, pale yellow, becoming convex and darker or greenish yellow with age, the mouths small, subrotund; stem equal, solid, furfuraceous, pale yellow; spores oblong-fusiform, .0005 to .0006 in. long, .00016 to .0002 broad.

The smoothish-stemmed Boletus is well marked by its cylindric minutely scurfy stem which is colored like the tubes. Its cap is smooth and nearly always some shade of red or bay. Specimens occur occasionally in which it approaches grayish brown or wood-brown. The flesh is white and unchangeable when cut or broken.

The tubes at first have a nearly plane surface but this becomes somewhat convex with age, and slightly depressed around the stem. The tube mouths are small and nearly round. The color of the tubes is at first a beautiful pale yellow but it becomes darker or slightly greenish yellow with age.

The stem is colored very nearly like the tubes, but sometimes it has a slight reddish tint toward the base. Its peculiar feature consists of the minute branny particles upon it. They are so small and pale that they are easily overlooked.

There is a variety in which the cap is corrugated or irregularly pitted anl wrinkled. Its name is *Boletus subglabripes corrugis* Pk.

The cap is 1½ to 4 in. broad, the stem is 2 to 3 in. long and 4 to 8 lines thick. The plants are found in woods in July and August.

Boletus edulis *Bull.* **var. clavipes** *Pk.*

Club-stemmed Boletus

Plate 54

Pileus fleshy, convex, glabrous, grayish red, bay red or chestnut color, flesh white, unchangeable; tubes at first concave or nearly plane, white and stuffed, then convex, slightly depressed around the stem, ochraceous yellow; stem mostly obclavate and reticulate to the base; spores oblong-fusiform, .0005 to .0006 in. long, .00016 to .0002 broad.

The club-stemmed Boletus is so closely related to the edible Boletus and so closely connected by intermediate forms that it seems to be only a variety of it, but one worthy of illustration. It differs in the more uniform color of the cap, in having the tubes less depressed around the stem and less tinted with green when mature and in having the stem more club-shape and commonly reticulated to the base. The lower reticulations are usually coarser but less per-

manent than the upper. The cap is more highly colored when young and is apt to become paler with age, but the margin does not become paler than the central part as it so often does in the edible Boletus. Individuals sometimes occur in which the stem is nearly cylindric and reticulated only on the upper part. These connect so closely with the edible Boletus that we have considered this to be a mere variety of it. In size and in edible qualities it is very similar to that species.

Hydnum albidum *Pk.*

WHITISH HYDNUM

PLATE 56, *fig.* 1-7.

Pileus fleshy, thin, broadly convex or nearly plane, subpruinose, white, flesh white; aculei short, white; stem short, solid, central or eccentric, white; spores subglobose, .00016 to .0002 in. broad.

The whitish Hydnum is uniformly colored in all its parts. It grows in groups or in clusters. In the latter case the caps are sometimes irregular because of the crowded mode of growth and the stems are occasionally eccentric. It is a small species not liable to be mistaken for any other except possibly for very small pale forms of the spreading Hydnum. But wholly white examples of this species have never been seen by me.

The caps are 1 to 2 in. broad and the stems are generally about 1 in. long and 3 to 5 lines thick.

The plants grow in thin woods or in open bushy places and appear in June and July. It is not a common species and though well flavored it is not of very great importance as an edible mushroom because of its scarcity and small size.

Hydnum Caput-ursi *Fr.*

BEAR'S-HEAD HYDNUM

PLATE 56, *fig.* 8-12.

Fleshy, tuberculiform, immarginate, pendulous, white, the surface everywhere emitting short branches which are clothed with branchlets and subulate deflexed aculei; spores globose or subglobose, .0002 to .00024 in. broad.

The bear's-head Hydnum is intermediate between the coral-like Hydnum, *H. coralloides*, on one hand and the hedgehog Hydnum, *H. erinaceum*, and the medusa's-head Hydnum, *H. Caput-medusae*, on the other. By reason of the numerous short branches of its surface it is classed with the branching species of the tribe Merisma, but on account of its thick fleshy tuberculiform body it shows a close connection with the unbranched tuberculiform species. The American fungus is not always pendulous, and in this respect it differs from the typical form described by Prof. Fries.

When it grows from the upper side of a prostrate trunk it is erect or nearly so. When it grows from the side of a standing or of a prostrate trunk it may be either ascending or pendulous, or it may develop in both directions. The solid body is sometimes elongated and narrow, sometimes short and thick. Its branches are often scarcely more than tuberculiform projections or processes and the general outline of the whole fungus sometimes bears a striking resemblance in size and shape to the heart of an ox. The spine-like teeth vary much in length. They are generally from 4 to 12 lines long, and point downward. They are longer than in the coral-like Hydnum and shorter than in the hedgehog Hydnum. The whole plant is white and beautiful when fresh and young, but with age and in drying it assumes creamy white, yellowish or pale alutaceous hues. It has sometimes been referred to *Hydnum Caput-medusae* by American mycologists but its branching character and the entire absence of grayish or cinereous colors forbid such a reference.

It usually forms masses from 2 to 6 inches thick and high, but it sometimes greatly exceeds these dimensions. It grows upon dead or decaying wood of deciduous trees, specially of beech and birch and is mostly found in woods in summer and autumn.

This species is not classed among the edible mushrooms by European mycologists and Prof. Fries says that its substance is tough and dry, and that he would scarcely think it edible. My own experiments with it lead me to think it less tender and savory than the coral-like Hydnum, still it is agreeable, digestible and harmless and much better than some species that are generally considered very good. Its great mass of firm flesh, free from larvae, clean white and

attractive, gives it value and importance which it would not otherwise have. It may be made specially useful to parties camping in the Adirondack wilderness who may have become tired of the ordinary fare of the camp or who may be running short of supplies. By cutting it in thin slices it can easily be dried and preserved for future use.

EXPLANATION OF PLATES

Plate A

Picea brevifolia *Pk.*

SWAMP SPRUCE

FIGURE

1 Part of a branch bearing staminate aments.

2 Part of a branch with ovule-bearing aments.

3 Part of a branch bearing two mature cones and three staminate aments.

4 Large and old cone with opened scales.

5 Four seeds, two of them with wings removed.

6 Single leaf.

Var. semiprostrata *Pk.*

7 Part of a branch.

8 Single leaf.

Plate B

Mycena cyaneobasis *Pk.*

BLUE-ROOTED MYCENA

1 Two young plants with the cap moist and highly colored.

2, 3, 4 Three mature plants with pale caps, two of them showing a part of the under surface.

5 Vertical section of a cap and the upper part of its stem.

6 Transverse section of a stem.

7 Four spores x 400.

Clitocybe fellea *Pk.*

BITTER CLITOCYBE

8 Two immature plants.

9 Two mature plants.

10 Vertical section of a cap and the upper part of its stem.

11 Four spores x 400.

Pholiota marginella *Pk.*

SLIGHT-MARGINED PHOLIOTA

12 Cluster of four young plants.

13 Young plant showing a part of the under surface of the cap.

14 Mature plant showing a part of the under surface of the cap.

FIGURE

15 Two plants, one young, the other mature and with its cap faded.

16 Mature plant with its cap faded and the center depressed.

17, 18 Vertical sections of two caps and the upper part of their stems.

19 Transverse section of a stem.

20 Four spores x 400.

Gyromitra sphaerospora *Sacc.*

GLOBOSE-SPORED GYROMITRA

21 Young plant.

22 Mature plant.

23 Mature plant showing the under surface of the cap.

24 Paraphysis and an ascus containing eight spores x 400.

25 Four free spores x 400.

Plate 50

Amanitopsis strangulata *Roze*

STRANGULATED AMANITOPSIS

1, 2 Two young plants.

3 Plant with the cap partly expanded.

4, 5 Two mature plants with their caps fully expanded.

6, 7 Vertical section of two caps and the upper part of their stems.

8, 9 Transverse sections of two stems.

10 Four spores x 400.

Collybia velutipes *Curt.*

VELVET-STEMMED COLLYBIA

11 Cluster of seven young plants with pale stems.

12, 13 Two clusters of mature plants.

14 Single mature plant.

15 Vertical section of a cap and the upper part of its stem.

16 Four spores x 400.

Plate 51

Clitocybe monadelpha *Morg.*

CLUSTERED CLITOCYBE

1 Cluster of plants, two of them showing scales and fibrils on the caps.

FIGURE

2 Single mature plant.

3 Vertical section of the cap of a young plant and the upper part of its stem.

4 Vertical section of the cap of a mature plant and the upper part of its stem.

5 Four spores x 400.

Hygrophorus flavodiscus *Frost*

YELLOW-DISKED HYGROPHORUS

6 Young plant.

7 Mature plant with the cap partly expanded.

8 Mature plant with the cap fully expanded.

9 Vertical section of a cap and the upper part of its stem.

10 Transverse section of a stem.

11 Four spores x 400.

Plate 52

Collybia radicata *Relh.*

ROOTED COLLYBIA

1 Young plant.

2 Mature plant showing radiating wrinkles on the center of the cap.

3 Form having a white cap.

4, 5 Vertical sections of two caps and the upper part of their stems.

6, 7 Transverse sections of two stems.

8 Four spores x 400.

Var. furfuracea *Pk.*

9 Plant with the cap partly expanded and corrugated on the center.

10 Plant with the even cap fully expanded.

11 Four spores x 400.

Var. pusilla *Pk.*

12, 13 Two plants, one with the cap fully expanded.

14 Four spores x 400.

Plate 53

Russula roseipes *Bres.*

ROSY-STEMMED RUSSULA

FIGURE
1 Young plant.
2 Plant with cap partly expanded.
3, 4 Two mature plants, one with the cap nearly plane.
5, 6 Vertical sections of the caps of two plants and the upper part of their stems.
7 Four spores x 400.

Russula ochrophylla *Pk.*

OCHERY-GILLED RUSSULA

8 Young plant.
9, 10 Two mature plants.
11 Vertical section of a cap and the upper part of its stem.
12 Four spores x 400.

Var. albipes *Pk.*

13 Immature plant with the cap partly expanded.
14 Mature plant.

Plate 54

Boletus edulis *Bull.* **var. clavipes** *Pk.*

CLUB-STEMMED BOLETUS

1 Young plant.
2 Young plant with the cap slightly expanded showing the whitish under surface.
3 Plant nearly mature.
4 Mature plant of small size.
5 Mature plant of large size with the stem nearly cylindric and reticulated on the upper part only.
6 Vertical section of the cap of a young plant and the upper part of its stem.
7 Vertical section of the cap of a mature plant and the upper part of its stem.
8 Four spores x 400.

Plate 55

Boletus subglabripes *Pk.*

SMOOTHISH-STEMMED BOLETUS

FIGURE

1, 2 Two young plants.

3 Immature plant showing the color of the young tubes.

4 Mature plant with reddish stains at the base of the stem.

5 Vertical section of the cap of an immature plant and the upper part of its stem.

6 Vertical section of the cap of a mature plant and the upper part of its stem.

7 Four spores x 400.

Var. corrugis *Pk.*

8 Immature plant.

9 Mature plant with reddish base of the stem.

10 Vertical section of a cap and the upper part of its stem.

Plate 56

Hydnum albidum ***Pk.***

WHITE HYDNUM

1 Group of four plants.

2 Single plant of medium size.

3 Plant having the cap wavy on the margin.

4 Plant having the stem eccentric.

5, 6 Vertical sections of two caps and the upper part of their stems.

7 Four spores x 400.

Hydnum Caput-ursi *Fr.*

BEAR'S-HEAD HYDNUM

8 Small plant of vertical growth.

9 Plant of lateral growth.

10 Vertical section of a plant of vertical growth.

11 Vertical section of a plant of lateral growth showing both erect and pendulous development.

12 Four spores x 400.

PICEA BREVIFOLIA, PECK
SWAMP SPRUCE

C. H. Peck, Del.

Figs. 1-10 **AMANITOPSIS STRANGULATA** Roze
STRANGULATED AMANITOPSIS

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C. H. Peck, Del.

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COLLYBIA RADICATA Relh
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C. H. Peck, Del.

BOLETUS EDULIS Bull. var. CLAVIPES Peck
CLUB-STEMMED BOLETUS

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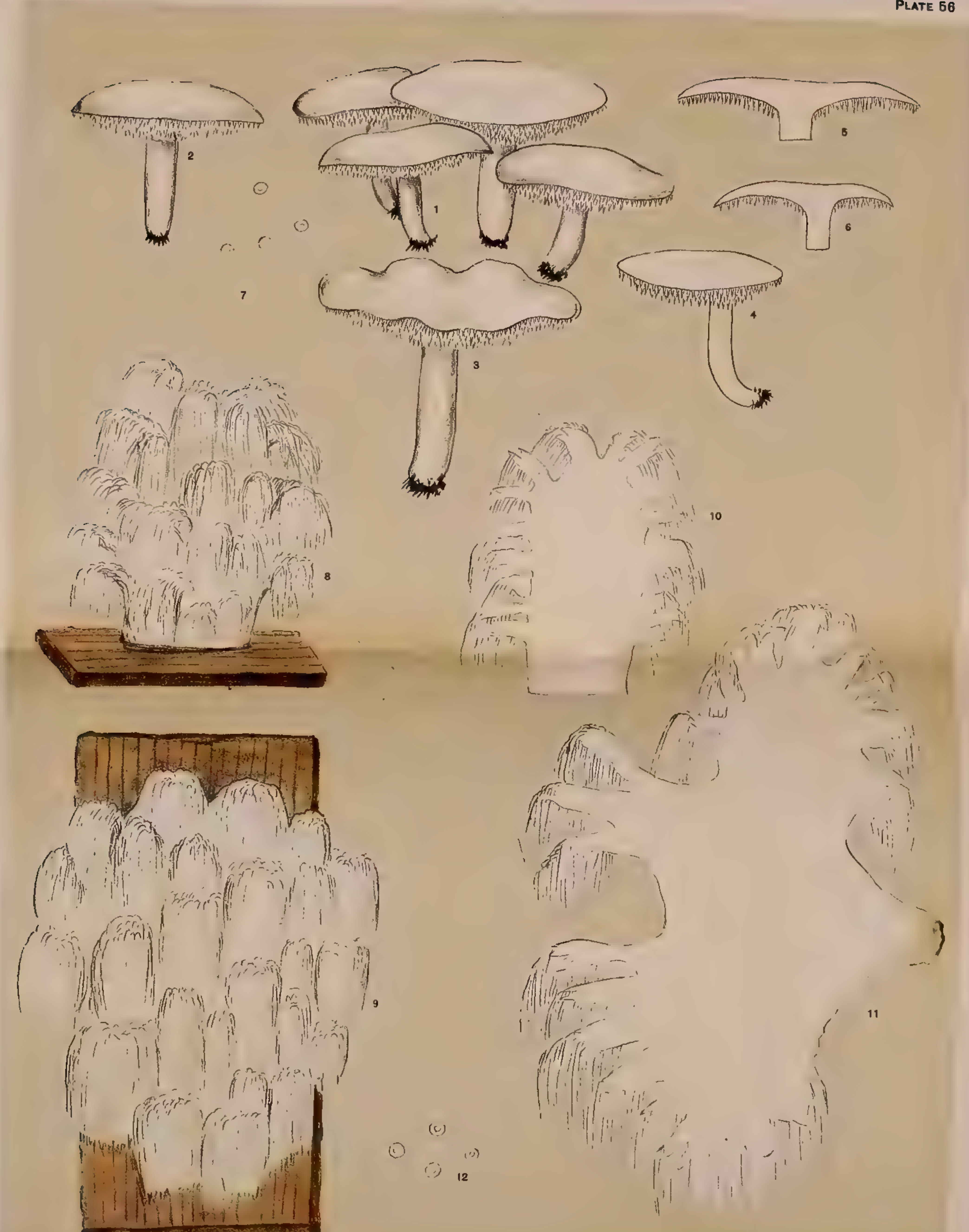
BOLETUS SUBGLABRIPES Peck

SMOOTHISH-STEMMED BOLETUS

EDIBLE FUNGI



C. H. Peck, Del.

Figs. 1-7 **HYDNUM ALBIDUM** Peck
WHITE HYDNUM

Figs. 8-12 **HYDNUM CAPUT-URSI** Fr.
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REPORT

OF THE

STATE ENTOMOLOGIST

1897

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[a] A bibliography and general account is given of each.

REPORT

Office of the State Entomologist
Albany, *December* 15, 1897

To the Regents of the University of the State of New York

Gentlemen: I have the honor of presenting my 13th report on the injurious and other insects of the state of New York, for the year ending Sept. 30, 1897, containing in the main the results of observations and studies made by me during the year, together with some of the details pertaining to my official work.

Copies of the 11th report for the year 1895, were received last January, and about 600 have been distributed to societies, to students in entomology in this country and abroad, and to agriculturists and others to whom its contents should be of interest and value.

The minor publications made during the year, usually in reply to inquiries of insect attacks of more or less general interest, and contributed to agricultural or local newspapers, were 40 in number. Abstracts of these are given in the appendix to this report, after the manner adopted in preceding reports. Some of the more important of these notices are published in full, or extended in the annual reports. A list of earlier publications of the entomologist briefly summarized, 501 in number, extending from 1870 to 1888, may be found in the volume, entitled *Bibliography of the more important contributions to American economic entomology*, published in 1896 by the U. S. department of agriculture, division of entomology.

The additions to the state collection of insects have not been as large as in previous years, as no special time was devoted to field collections

The number received from correspondents, accompanied usually with inquiries of their name or means of control, was about 350, from 52 individuals.

The correspondence of the office has not varied materially from that reported in preceding years. The record of letters sent is 1235. Of all those to which reference might be desirable hereafter, copies have been retained, and placed on file. The letters received, indorsed, and filed, during the year are 910 in number.

The year has not been marked by any wide-spread insects ravages in the state of New York, or by the introduction of any formidable insect pest from abroad. The army-worm, in accordance with its accustomed limitation of serious injury to a single year, did not again make its appearance in formidable number. The San José scale is not spreading rapidly over the portions of the state liable to its introduction. New localities for it not hitherto reported, are Niagara, Ontario county; Farmer, Seneca county; and Poughkeepsie, on the Hudson river. Apparently, conditions have not been favorable for its spread, and it is very encouraging to state that in the examinations of 35 western nurseries by my assistant, Dr E. P. Felt, in not a single instance was the pest discovered. In none of the localities in the state where it has been detected, with the exception of Long Island, has the scale spread to any serious extent, and in most of them it is believed to have been exterminated. In view of the grave apprehensions that had been entertained of the destructiveness and stubborn character of this pest, it is very gratifying to have received the recent announcement by Dr J. B. Smith, entomologist of the New Jersey agricultural experiment station, that it can be exterminated by spraying the infested trees with pure kerosene during the winter after Jan. 1 and again in July, and in the following summer should it prove necessary.

The early spring months indicated an unusual prevalence of aphides upon crops and fruit trees, but later conditions prevented any very serious injuries from them.

In reviewing the year, it may be said that the losses from insect injuries sustained in New York were below their usual amount. This, in part, may be owing to greater watchfulness of our agriculturists, and their better knowledge of the methods recommended for the protection of their crops. The state has so liberally provided for the study of insect injuries that there is no good reason why the marked advance in methods of dealing with our insect enemies should not be generally utilized by the people of the state.

Respectfully submitted

J. A. LINTNER

State entomologist

INJURIOUS INSECTS

Tenthredo rufopectus *Norton*

Red-breasted saw-fly

Ord. HYMENOPTERA: Fam. TENTHREDINIDAE

Norton, Edward. Boston journal of natural history. 1860. 7:255–56,[a] no. 38 (male and female described, from Conn , Pa.; as *Allantus*); Boston society of natural history. Proceedings. 1862. 9:121 (referred to *Tenthredo*); American entomological society. Transactions. 1868–69. 2:237 (description, distribution).

Cresson, E. T. Synopsis of the Hymenoptera of America. 1887. p. 168 (reference).

Harrington, W. H. Canadian entomologist. 1890. 22:25 (taken at Ottawa in June and July); Ottawa naturalist. 1893. 7:125 (taken early in July); Canadian entomologist. 1894. 26:197 (mention).

Smith, J. B. Catalogue of the insects of New Jersey. 1890. p. 14 (listed).

Osborn, Herbert. Partial catalogue of the animals of Iowa. 1892. p. 17 (listed).

For the past 15 years the stems of currant bushes in widely separated localities have been injured more or less by an insect boring in the tender tips, causing them to wilt or lop over and eventually die. It was not till 1891, however, that the author of the mischief was reared and identified as *Janus flaviventris* Fitch, which has since been referred by Mr A. D. MacGillivray to *Janus integer* Norton (*see* Bull. 126 Cornell agricultural experiment station. 1897. p. 41). Up to the present year there has been no reason for suspecting that there was more than one insect injuring the currant stems in this particular manner.

New currant pest. The currant twigs of Mr Thomas Tupper of Corning, N. Y., have suffered more or less from the currant stem girdler, *Janus integer*, for the past 10 years, although the insect was not identified till 1891. In 1895 Mr Tupper informed me of his finding several black saw-flies associated with the currant stem borer, which he thought might be the male of that species. Specimens of this black insect were finally obtained, both by captures in the field and by rearing from infested twigs. They were submitted to the division of entomology, U. S. department of agriculture, where they were identified by Mr Marlatt as *Tenthredo rufopectus* Norton.

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[a] Volume and page references are separated by a colon, e. g. 7: 255-56 means volume 7, pages 255-56.

There appears to be no record by American entomologists of injury to the currant or any other plant by this insect. It is apparently a new depredator on this shrub. Notwithstanding its general resemblance in appearance, it can hardly be said that it is closely allied to *Janus integer*, since the latter is referred to the *Uroceridae* — a family with females having ovipositors adapted for boring in solid wood, in which their larvae, as a rule, find sustenance. On the other hand, the *Tenthredinidae* are largely phyllophagous, the females ovipositing in or upon the softer vegetable tissues. A careful comparison of the two insects above named reveals marked structural differences.

Anomalous boring habit of the larva. Of the 24 British species of *Tenthredo* described by Cameron, the larvae of only 10 are mentioned, and each one of these is an external feeder. The habits of the Tenthredo larvae in this country appear to be practically unknown, and we have found no record of any of the species living within the stems of plants.

In Great Britain, in the closely allied genus of *Poecilosoma*, *P. candidatum* Fall., is recorded as boring in the pith of rose branches in much the same way as *Tenthredo rufopectus* is supposed to work in the currant stems. The perfect fly appears about the middle of April or early in May and lays her eggs singly in the tips of the young branches. The newly hatched larva bores into the pith, 'whereby the leaves become withered, and then damage is done to the plant.'[a] Two species of *Cryptocampus*, *C. saliceti* and *C. angustus*, are also recorded by Mr Cameron as boring in the pith of young willow twigs of several species. Certain species of *Euura* and *Pontania* are said to pass their early stages within stems of plants without forming galls, that is, they are practically borers. *Emphytus maculatus* according to Riley deposits her eggs in the stem of the cultivated strawberry, and by 'their presence causing a swelling in the stalk.' The larvae of some other species of *Tenthredinidae* live in galls, in various fruits, or within mines in leaves, the great majority, however, appear to be external leaf feeders. The full grown larvae of some of these insects are known to bore into stems of plants for the purpose of finding a suitable place for pupation.

Description. The perfect insect may be distinguished from *Janus integer* (plate 1, fig. 2) by the body being entirely black and the abdomen flattened above (depressed), while in the latter the abdomen is flattened on the sides (compressed). The abdomen of the male of *Janus*

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a Cameron: *Monograph of the British phytophagous hymenoptera* 1882. 1:210.

integer is yellowish red, that of the female is broadly banded with the same color. The *Tenthredo* is also a stouter insect than the currant stem girdler. In length it measures about $\frac{4}{10}$ inch, and its wing-spread is twice its length. The coxae and femora of the anterior two pairs of legs are tipped with black, and the apical half of the posterior tibiae and their tarsi are black. The other characters of this insect may be recognized by the accompanying figure (plate 1, fig. 1).

The following is Mr Norton's description of the insect:

Female. Black, body not very stout; antennae long and slender; color ferruginous, tips of joints above black, sometimes also the two basal joints; labrum rounded; labrum, base of mandibles and palpi, tegulae, collar, and four radiating lines on ridges of metathorax, yellow; a white spot above base of posterior coxae; pectus and legs orange red; the four anterior tibiae and tarsi and the medial femora tipped with black; apex of posterior femora, apical half of tibiae and their tarsi black; wings hyaline, basal edge of stigma and the costa pale.

Male. The male has a yellow spot on each side of the disk of clypeus and on the pleura over each of the four hinder coxae; the first and second segments of abdomen and the basal segments of venter are sometimes indistinctly rufous.

Life history and habits. Very little is known of the life history and habits of this insect, as its operations in the currant stems at the same time as those of *Janus integer* has led to the ascribing of all the injury to that species. The perfect insects were observed on the currant stems at the same time as were those of *J. integer* by Mr Tupper, but their oviposition had not been noticed by him. The stems are probably injured seriously by this insect while ovipositing, since the attack is revealed by the wilted tips as in the case of the *Janus*. There is apparently but a single brood each year, as the imagoes have been taken in May at Corning, N. Y., and in June and early in July at Ottawa, Canada.

Distribution. This species is probably widely distributed over the northern United States. Its recorded distribution is as follows: New England, New York, New Jersey, Pennsylvania, Illinois, Iowa and Ottawa, Canada. There appears to be no record of it in the western states, although it will probably be found there later.

Remedy. The wilted tips should be watched for in the early spring, and as soon as seen should be cut off a little below the place of injury. If the attack should escape attention till some time after the dropping of the tips, the cutting should be made a few inches farther down, and beyond the burrow of the larva.

Urocerus albicornis *Fabr.*

White-horned Urocerus

Ord. HYMENOPTERA: Fam. UROCERIDAE.

Fabricius, J. C. Species insectorum. 1781. 1 : 419–20 (original description, from North America); Mantissa insectorum. 1787. 1 : 258 (mention); Entomologia systematica, emendata et aucta. 1793. 2 : 127 (from South America, all as *Sirex*).

Fitch, Asa. N. Y. State agricultural society. Transactions. 1857. 1858. 17 : 731 (brief account); the same in Insects of New York. 4th Rep't. 1858. p. 45.

Harris, T. W. Insects injurious to vegetation, 3d ed. 1862. p. 538–39 (brief account).

Norton, Edward. American entomological society. Transactions. 1868. 1869. 2 : 360–61 (bibliography, discription).

Walker, Francis. Canadian entomologist. 1873. 5 : 78 (in Europe and America, as *Sirex*).

Glover, Townsend. Commissioner of agriculture. Rep't. 1877. 1878. p. 93, pl. 1, fig. 15 (mention).

Harrington, W. H. Canadian entomologist. 1880. 12 : 97 (spinules of wing); ——1882. 14: 227 (at Ottawa, Ontario); Royal society of Canada. Transactions. Section 4. 1893. p. 138–44, 145, 153 (description, distribution); Entomological society of Ontario. 24th Rep't. 1894. p. 49 (mention).

Cresson, E. T. Synopsis of the hymenoptera of America. 1887. p. 172 (listed).

Cameron, Peter. Monograph of the British phytophagous hymenoptera. 1890. 3 : 134 (occurs in England).

Packard, A. S. U. S. Entomological commission. 5th Rep't. 1890. p. 733 (on pine).

Smith, J. B. Catalogue of the insects of New Jersey. 1890. p. 15 (listed).

MacGillivray, A. D. Canadian entomologist. 1893. 25 : 243 (from Washington).

Slosson, A. T. Entomological news. 1895. 6 : 317 (on Mt. Washington).

Lintner, J. A. Country gentleman. 1897. 62 : 707 (brief notice).

Of the interesting but rather limited family of the North American Uroceridae, in which six genera are included, about one half of the species are embraced in the genus *Urocerus*. This genus is one that evidently finds its most favorable conditions in the Canadian provinces, for while the Cresson *List of North American Hymenoptera* published 10 years ago, contains 24 species, Mr W. H. Harrington, writing in 1893,

states that 'nearly all occur in Canada. They are widely distributed throughout the Dominion from Nova Scotia to Vancouver island, and very far northward. The larvae of these insects are borers in coniferous trees, and their distribution is probably coextensive with the trees that they infest.'

The species named above is the one that more frequently comes under observation in the eastern United States, although it is far from common, and the male appears to be quite rare. Not a single example of the male has ever been taken by me or brought to my notice.

An example of the female was received August 31, from Carthage, N. Y., with the following statement:

The inclosed fly was seen a few days ago at a saw mill in Carthage, alighting on some freshly sawed spruce lumber, in the face of which it presently sank its ovipositor. The instrument was an inch or more long, fine as a needle, and went straight from the center of the body into the wood, taking six or eight minutes. It seemed operated by a lever movement of two thicker, shorter arms, and was drawn out by a reverse action.

Description and habits. The female may be easily recognized from the accompanying figure and the description given of it by Dr Harris as follows:

The white-horned Urocerus has white antennae, longer and more tapering than those of the pigeon Tremex, and black at each end. The female is of a deep blue-black color, with an oval white spot behind each eye, and another on each side of the hinder part of the abdomen. The horn on the tail is long, and shaped like the head of a lance. The wings are smoky brown, and semitransparent. The legs are black, with white joints. The body measures about an inch in length, and the wings expand nearly two inches (see plate 1, fig. 3).

Dr Harris has appended to the above a few words descriptive of the male, but it is doubtful if they pertain to this species. The males are not often met with, and from being seldom taken in association with the females, their proper reference is always doubtful. Mr Norton has remarked (see citation) of the examples of a male described by Dr Harris as *Urocerus abdominalis* which is found in the trunks of the white pine in July, that it may be *U. albicornis* or *U. flavicornis* (plate 1, fig. 4), but it is more probably the former. For its description, see the citation given above.

The several members of this genus are commonly known as horn-tails, from the horn-like projection at the end of the abdomen. The adults are usually found on the trunks of coniferous trees on bright days. The females are provided with an extended ovipositor designed to bore into wood. This organ consists of two guides about half an inch long and a

more slender median saw nearly an inch in length. Upon finding a suitable place, she drives this instrument with a sawing motion into the wood to its full length, and deposits her eggs therein.

Life history. The life history of this species has not been worked out. It is presumably similar to that of the other members of the genus. The eggs are deposited in pine or spruce, dying or diseased timber is apparently preferred, although they are known to oviposit in recently felled trees. The larvae run large burrows through the trunks, often rendering them unfit for building purposes. The imagos are abroad in July and August, but nothing seems to be recorded of the duration of either the larval or pupal stages of this insect.

Distribution. Fabricius records *U. albicornis* from both North and South America. Later observers have reported it from the following localities: New England; New York; New Jersey; Louisiana; state of Washington; Ottawa, Canada; Lake Winnipeg; Newfoundland; Northwest Territory. Cameron (see citation) calls attention to the fact that though this insect and other American species of the genus are taken from time to time in England, they are usually found near railway stations, mines and other places where they might easily have emerged from timber imported from America. He does not regard the species as indigenous to England. Its normal habitat is probably limited to the greater portion of the United States and British America.

Comparatively harmless. Although some allied species are regarded as quite injurious to pine forests in Germany, in this country their ravages are as a rule of not much economic importance. In most cases they attack only the diseased and dying trees.

Urocerus cressoni *Norton*

Ord. Hymenoptera: Fam. Uroceridae

Norton, Edward. Entomological society of Philadelphia. Proceedings. 1864. 3:16 (original description); American entomological society. Transactions. 1868–69. 2:361–62 (insect and varieties described).

Lintner, J. A. Country gentleman. 1884. 49:9 (brief account); Insects of New York. 5th Rep't. 1889. p. 311 (abstract of preceding).

Cresson, E. T. Synopsis of the hymenoptera of America. 1887. p. 173 (listed).

Smith, J. B. Catalogue of the insects of New Jersey. 1890. p. 15 (listed).

Harrington, W. H. Royal society of Canada. Transactions. Section 4. 1893. p. 139, 147, 148, 153 (description).

Cooley, R. A. Psyche. 1896. 7:397 (wing structure).

This interesting insect is closely allied to *U. albicornis* of a preceding page, from which it differs mainly, in having the 10 basal joints of the antennae black, and only the hind tibiae and tarsi white-banded.

Description of the imago. At first glance, this insect, with its wings folded upon its back, looks not much unlike one of the large black wasps (*Pompilius*), but on closer examination it is seen to be one of the peculiar hymenopterous forms commonly known from their formidable projecting ovipositor, as horn-tails. It may be distinguished from its allies by the apical eight or 10 segments of the antennae being straw-white, except the tip of the terminal segment which is brown; the others are brownish or black in color. A spot behind each eye is yellowish, the thorax black, the wings smoky brown, and the abdomen above yellowish brown, the terminal segments being darker. The base of both tibiae and tarsi of the legs in the example before me are yellowish, there being but little of it on the anterior two pairs.

The following more detailed description is from Mr Norton:

Female. Black; antennae 20-jointed, the 10 apical articles straw white, the base of the 11th and tip of the apical article brown; a rufous spot (not defined at edges) back of each eye; the six basal segments of the abdomen of a soft velvety violaceous brown; remaining segments rufous: cornu compressed at base, lance shaped; ovipositor not longer than abdomen and cornu together; legs black, the base of posterior tibiae and of first joint of their tarsi white; remaining joints blackish; all the claws red; wings obscure brownish violaceous, nervures piceous; cross nervure of second brachial cell incomplete.

This species is comparatively rare in this vicinity. Two interesting varieties have been described, one from Albany, N. Y., and the other from New Jersey (see citation).

Life history and distribution. The larva, hatched from the egg, when it approaches maturity, is able to excavate large burrows within the trunk, to the serious injury of the tree that it infests. In its general appearance it is long, cylindric, with six legs, a small, rounded head, and a pointed horny tail. When it attains its growth, it undergoes its transformations within a cocoon of chips built at the end of the burrow and spun together with silk. The length of time that it remains in its grub state is not known.

This insect has been recorded from New York, New Jersey and Pennsylvania. Its rarity has probably prevented its being detected in many localities where it occurs, although it is undoubtedly much less common and with a more restricted range than *U. albicornis.*

New York species of Urocerus and table for their separation

In addition to the two forms herein discussed, the following species o *Urocerus* have been recorded from this state: *U. edwardsii*, *U. zonatus* *U. cyaneus*, *U. nigricornis*, *U. abdominalis* and *U. flavicornis*. I have also taken a specimen of *U. tricolor* Prov. at Schoharie, N. Y.

The following table of species, adapted from Norton, is given as an aid in naming our New York species:

1 Antennae of one color, apical horn of female triangular, not spear-shaped	
Legs and abdomen black	*edwardsii* Brullé
Legs and abdomen yellow-banded	*zonatus* Norton
Legs rufous, abdomen blue	*cyaneus* Fabr.
Legs rufous, abdomen banded	*nigricornis* Fabr.
2 Antennae banded with white or yellow, apical horn spear-shaped	
Base of all the tibiae yellow, third and fourth abdominal segments purple-brown	*tricolor* Prov.
Base of all the tibiae yellow	*albicornis* Fabr.
Base of all the tibiae yellow, abdomen yellow-red (possibly the male of *albicornis*)	*abdominalis* Harris
Base of hinder tibiae yellow	*cressoni* Norton
All the tibiae and tarsi yellow	*flavicornis* Fabr.

Eacles imperialis *Drury*

Imperial moth

Ord. LEPIDOPTERA: Fam. BOMBYCIDAE

Drury, Drew. Illustrations of exotic entomology. 1773. 1:17 pl. 9, fig. 1, 2 (described as *Attacus*).

Smith, J. E & Abbot, John. Natural history of the rarer lepidopterous insects of Georgia. 1797. 2:109, pl. 55 (as *Phalaena imperatoria*).

Palisot de Beauvois, A. M. F. J. Insectes recueillis en Afrique et en Amérique dans les royaumes d'Oware. 1805. p. 52, pl. 20 (as *Bombyx didyma*).

Fitch, Asa. Insects of New York. 4th Rep't. 1858. p. 56–57 (larva described, as *Ceratocampa*); the same in N. Y. State agricultural society. Transactions. 1857. 1858. p. 742–43.

Harris, T. W. Insects injurious to vegetation. 3d ed. 1862. p. 402–5, fig. 196, 197 (brief account, as *Dryocampa*).

Morris, J. G. Synopsis of the Lepidoptera of North America. 1862. p. 230 (description, food-plants, as *Ceratocampa*).

Packard, A. S. Entomological society of Philadelphia. Proceedings. 1864. 3:381–2 (synonymy); Guide to the study of insects. 1869. p. 300 (mention); U. S. Entomological commission. 5th Rep't. 1890. p. 218, 282, 396 (list of food-plants), 425, 481, 514, 636, 646, 771–72 (brief account), 857, 893, 909, pl. 6, fig. 1, *a*, *b* (figures colored, brief mentions except where otherwise stated); American philosophical society. Proceedings. 1893. 30:139–40 (larva compared with that of *Aglia tau*), p. 157–63, pl. 6 (detailed life history); N. Y. Entomological society. Journal. 1893. 1:7 (mention); First memoir on the bombycine moths. 1895. p. 39 (ontogeny).

Riley, C. V. American entomologist and botanist. 1870. 2:340 (mention, as *Dryocampa*); U. S. Dep't Agriculture, Division entomology. Bulletin 31. 1893. p. 49 (feeding on leaves of cotton-plant).

Lintner, J. A. Country gentleman. 1871. 36:600 (brief mention, as *Dryocampa*); Entomological contributions. 1872. 2:46–50 (larval stages described); the same reprinted in N. Y. State museum. 24th Rep't. 1872. p 150–54; Country gentleman. 1883. 48:781 (brief general account); Insects of New York. 2d Rep't. 1885. p. 232 (abstract); —— 4th Rep't. 1888. p. 20, 21 (on hemlock); —— 5th Rep't. 1889. p. 324 (mention); —— 9th Rep't. 1893. p. 462 (mention); —— 10th Rep't. 1895. p. 481 (taken in July, August).

Reed, E. B. Entomological society of Ontario. Rep't. 1872. 1873. p. 37 (reference, as *Dryocampa*).

Andrews, W. V. Canadian entomologist. 1874. 6:17 (parthenogenesis of), p. 146–47 (coloration of larva).

Gentry, T. G. Canadian entomologist. 1874. 6:87–88 (larva and varieties described).

French, G. H. Insects of Illinois. 7th Rep't. 1878. p. 196 (on buttonwood, mention).

Siewers, C. G. Canadian entomologist. 1878. 10:85 (house ants attacking larvae).

Hulst, G. D. Brooklyn entomological society. Bulletin. 1880. 2:77 (food-plants).

Bell, J. T. Canadian entomologist. 1881. 13:59 (mention).

Edwards, W. H. Psyche. 1881. 3:174 (mention, as *Dryocampa*).

Marten, John. Insects of Illinois. 10th Rep't. 1881. p. 121 (brief mention).

Brooklyn entomological society. Check list of the Macro-lepidoptera of America. 1882. p. 9, no. 1102 (listed, as *Dryocampa*).

Fernald, C. H. Standard natural history. Kingsley's. 1884. 2:454, fig. 574 (brief mention).

Schofield, S. Psyche. 1884. 4:175 (mention, as *Ceratocampa*).

Wailly, Alfred. Psyche. 1885. 4:314 (cannibalism of larva, as *Ceratocampa*); —— 1888. 5:118 (mention, as *Ceratocampa*).

Beutenmüller, William. Entomologica Americana. 1886. 2: 53 (list of food-plants).

Harrington, W. H. Entomological society of Ontario. 17th Rep't. 1887. p. 29 (rare in Canada).

Dimmock, A. K. Psyche. 1888. 5: 28 (molts, as *Ceratocampa*).

Hagen, H. A. Psyche. 1888. 5: 135 (listed).

Riley, C. V. & Howard, L. O. Insect life. 1889. 1: 379 (on elm, as *Dryocampa*).

Smith, J. B. Catalogue of the insects of New Jersey. 1890. p. 303 (usually common); List of the lepidoptera of boreal America. 1891. p. 32, no. 1373 (synonymy); American entomological society. Transactions. 1893. 20: 35 (synonymy, as *Citheronia*, after Kirby).

Dyar, H. G. Psyche. 1891. 6: 129 (at light, June to August).

Neumoegen, Berthold. Entomological news. 1891. 2: 150–51 (ab. *punctatissima* and var. *nobilis* described).

Southwick, E. B. Insect life. 1891. 4: 61 (mention).

Kirby, W. F. Synonymic catalogue of lepidoptera heterocera. 1892. 1: 933 (synonymy, as *Citheronia*).

Osborn, Herbert. Partial catalogue of the animals of Iowa. 1892. p. 19 (listed, as *Dryocampa*).

Mason, J. T. Entomological news. 1893. 4: 157 (var. from Texas).

Neumoegen, Berthold & Dyar, H. G. N. Y. Entomological society. Journal. 1894. 2: 151–52 (synopsis of varieties, as *Basilona*).

Comstock, J. H. & A. B. Manual for the study of insects. 1895. p. 346, fig. 425 (brief account, as *Basilona*).

Cooley, R. A. Psyche. 1896. 7: 397 (mention).

Howard, L. O. U. S. Dep't agriculture. Office of experiment stations. Bulletin 33. 1896. p. 345 (feeding on cotton plant); reprinted in U. S. Dep't agriculture. Farmers' bulletin 47. 1897. p. 26.

Soule, C. G. Psyche. 1897. 8: 155 (on *Prunus serotina*).

Though this insect is not noted for marked injuries to anyone of its numerous food-plants it is of special interest to everyone who chances to meet with it, from its strange appearing larva and the large size of the beautiful moth. The imagos are such desirable additions to the cabinet that the larvae are eagerly sought after by collectors, since it is only by rearing that the more perfect examples can be obtained.

Notes on the life history. A pair of these beautiful and rare moths was taken in coition by a gentleman in Greenbush (now a portion of the city of Rensselaer), in June of 1869, and remained in that state while being brought across the river to Albany. In the box with them were some twigs and leaves of chestnut (*Castanea*

vesca), with a number of eggs already deposited on them, from which circumstance, in the absence of any accompanying statement, it may be presumed that the moths were captured on that tree. A large number of eggs were subsequently deposited by the moth, of which, through the kindness of Mr Louis Sautter, 85 were brought to me, which were said to have been laid June 25. When the eggs were received by me on the 30th, they showed a circular depression on their flattened surface, which, in the eggs of many of our moths, indicates an advanced stage in their development. They were of a light honey-yellow color, with some reddish spots or clouds maculating their border. By July 2d the larvae could be plainly seen in frequent motion in a few of the eggs, through the transparent shell. On the following day, the larval bands were quite visible.

Four of the larvae were disclosed July 4, and 12 additional during the five days following; of these the last ones to emerge were quite feeble—four of them dying without partaking of food. None of the other eggs developed, probably from failure in fertilization, resulting from a disturbed coition. Thus it will be seen that the duration of the egg stage was from nine to 14 days.

The larvae fed only at long intervals, passing most of their time in wandering over the leaves or resting on their petioles. One larva molted July 11; two the 12th and four on the night of the 14th. Two larvae were in position for the second molting on the 16th, indicating progress in the change by their translucent, empty head-cases and the withdrawn heads covered by the skin of the first segment. The entire integument was cast the following day. The two surviving larvae molted for the third time July 30 and August 2. The fourth molt of the sole survivor occurred on the 15th. Unfortunately, it died of diarrhoea three days later—the result, probably, of its having been fed for so long a time on a food plant unnatural to it. The chestnut leaves which were at first given to the young larvae were refused. It not being convenient to provide them with buttonwood, its only food-plant as given by Harris, oak, mentioned by Abbot as one of their food-plants in the south, was procured for them, upon which they fed, but at no time in a very earnest manner. An attempt was afterward made to transfer them to pine, on which Dr Fitch states that they are almost invariably found in the northern states, but they were unwilling to make the change.[a] The small size of the one larva which passed the fourth molt successfully,

[a] Dr Hulst states that these larvae are difficult to rear in confinement, though hardy under natural conditions.

indicated that there was probably an additional molting prior to pupation, but the rearing of the species later by Dr Packard seems to show conclusively that there are but four molts — the same number found by Mr Edwards (see citation).

During the following month (September 1869), from the 7th to the 16th, 14 individuals were taken by me, and as many more by Mr Meske, of Albany, from the lower branches of a number of pines (*Pinus strobus*) bordering a road in the Forbes manor, at Bath. Their presence on a tree was in most instances readily revealed by the large pellets of their excrement lying upon the smooth gravelled road beneath, when, from the robust form of the larva in marked contrast with the slender leaves surrounding it, its resting place was not difficult to detect. On the 7th one was taken which had just completed its last molting; on the 9th one was observed in the process of molting, which, from some irregularity attending it, had fallen to the ground; and on the same day one which had already assumed the brown or tawny hue indicative of its full maturity was taken while moving down the trunk of a tree to seek its place for pupation. The most advanced one of the others collected matured on the 11th, and transformed to a pupa on the surface of the ground on the 16th of the month. Most of the remainder entered the ground, where they constructed cells of moderate dimensions for their pupal transformation.

The pupae were kept in a cold room during the winter, and about March 1 were removed to a warm apartment. April 28, May 3 and 7, male imagos emerged, after which females were disclosed till near the end of the month. Dr Dyar reports (see citation) that from June 20 to August 4, 40 examples of the moth were captured at electric lights in Poughkeepsie, N. Y., of which 16 were taken on July 9.

In September 1870, diligent search was again made for the larva in the locality at Bath, where it had been abundant the preceding year, as above recorded, without finding a single individual. Its non-occurrence indicates a marked periodicity in the appearance of the species or, possibly, an exhausted locality from the collections made.

Description of the egg. The following is Dr Packard's description of the egg of this insect:

Length, 3 mm; breadth, 2.5 mm; thickness, 2 mm. Flattened elliptic, ends alike, white, with an equatorial, smooth, distinct ridge. The shell is white, the surface under a high power triplet is seen to be finely pitted, the pits being shallow and not closely crowded. Under a half-inch objective the pits are seen to be shallow, and not often with a definite raised edge: often there is a boss or bead in the center. Arising

from the spaces between the bosses are slender, short, very minute hairs, originating from a swollen base. Under a one-fifth objective, as well as a one-half and a triplet, I can not distinguish between the microscopic structure and markings of *imperialis* and *regalis*.

Just before hatching the eggs are yellowish with reddish spots or clouds maculating their circumference.

Description of the larval stages. *Young larva.* The newly emerged larva measures $\frac{1}{4}$ inch in length. The head is red, round and smooth. Body of a dull red color, armed, except on the last two segments, with six rows of bristle-tipped spines: the subdorsal spines on the second and third segments are nearly one third the length of the body, black, rugose, bifurcated, each prong tipped with a white acute bristle; on the top of the 11th segment is a similar spine resting on a red, conical tubercle. The segments are annulated with three fuscous bands terminating laterally at the stigmatal flexure, of which one precedes, and two follow the spines: the terminal segment declines considerably from the plane of the others. Legs, black; prolegs, red.

First molt. Length of larva $\frac{1}{2}$ inch. Head glossy, ferruginous, fuscus at the clypeus and about the eyes. Collar and terminal segments, ferruginous. The segments are testaceous centrally, shading into an obscure red at the incisures, the transverse bands which had previously marked them having disappeared. The spines are glossy black with branches tipped with white acute bristles; the two long spines of the second and third segments each and the medial one of the 11th, which are about one fifth the length of the body, are directed slightly forward; their two forks are of unequal size; the last mentioned spine is in addition to the six of the preceding segments, and ranges with the four substigmatal and lateral spines, the two subdorsal being placed farther back on the segment: the terminal segment has 13 spines, viz, six occupying the usual position, a seventh medial one behind the range of the preceding, four on the anal shield, of which the two anterior are the larger (four others are indicated by acute granulations on the posterior margin), and a small one on each terminal leg exteriorly. The stigmata are broadly elliptic, fuscous, and situated on a distinct, elliptic, testaceous spot. Legs and prolegs testaceous, marked outwardly with fuscous.

Second molt. July 17. Length, $\frac{6}{10}$ inch. Immediately succeeding the molt the head is pale red, and the long spines before noticed, now appearing as horns, are pearly white.

Three days thereafter, the larva measures $\frac{8}{10}$ inch in length. The head is dull ferruginous, with fuscous centrally and laterally. The body

is of an umber brown, lighter at the incisures, gray dorsally with a dark vascular line; segments with a few white hairs, the longest of which surround the subdorsal spines; horns of second, third and 11th segments curved, glossy black, with base luteous; spines dull black. Anal shield marked with a cordiform, glossy black spot, having central and marginal rufescent granulations; anal plates with a subtriangular, granulated fuscous impression. Stigmata surrounded with a dark brown ring. Legs shining black; prolegs with a black spot exteriorly, and with fuscous near the plantae.

Third molt. Length, 1 inch. The head and color of the body are as before. A marked feature at this stage is the presence of long white hairs given out from the central portion of the segments, of which the superior ones are nearly twice the length of the thoracic horns, and the lateral ones shorter; similar hairs of medium length project laterally over the proleg-bases. The horns are $\frac{18}{100}$ inch long, of a honey-yellow color, and are studded with conical projections (of which the two apical are fuscous), bearing a short, acute, fuscous spinule. The spines of the two subdorsal rows are $\frac{5}{100}$ inch long, of the color of the head, and (except two exterior to the horns) have two fuscous, spinule-tipped projections. The lateral row consists of tubercles, of which those on the anterior segments are simple, and on the terminal ones branched, of a darker shade of color than the subdorsal spines. The substigmatal row is composed of still smaller simple tubercles. Anal shield brown with whitish granulations, bordered with tubercles, of which two are branched; anal plates fuscous centrally. Legs ferruginous; prolegs fuscous on the outer side.

Fourth molt. Length, $1\frac{3}{4}$ inch. A marked change occurs in the horns at this molting. From being as heretofore cylindric they are now conical, are armed with stout spinules, and have become shorter; the the length of the thoracic ones is $\frac{12}{100}$ inch, of the posterior one, $\frac{1}{10}$ inch. The anal plates are conspicuously marked with whitish granulations. The stigmata are brown, with a central line and border of white, surrounded with fuscous on a subquadrangular testaceous patch.[a]

The full grown larvae have been described by Dr Harris as follows:

They are from 3 to 4 inches in length, and more than $\frac{1}{2}$ inch in diameter, and, for the most part, of a green color, slightly tinged with red on the back; but many of them become more or less tanned or swarthy, and are sometimes found entirely brown. There are a few very short

[a] Lintner, J. A. *Entomological contributions*, no. 2, contained in the 24th annual report of the New York state museum, 1870, p. 150–54.

hairs thinly scattered over the body; the head and legs are pale orange colored; the oval spiracles, or breathing holes, on the sides, are large and white, encircled with green; on each of the rings, except the first, there are six thorny knobs on hard and pointed warts of a yellow color, covered with short black prickles; the two uppermost of these warts on the top of the second and third rings are a quarter of an inch or more in length, curved backward like horns, and are of a deeper yellow color than the rest; the three triangular pieces on the posterior extremity of the body are brown, with yellow margins, and are covered with raised orange colored dots.

The larval spines. The spines or tubercles in this species show remarkable variation and modification in the successive larval stages. The dorsal spines on the second and third thoracic segments in the newly hatched larvae are from nearly one third to about half as long as the body, very slender and deeply forked (plate 2, fig. 1, *c*, *d*). In the second stage, the dorsal spines on the posterior two thoracic segments and the eighth abdominal segment are stouter and not quite so deeply forked (plate 2, fig. 2, *b*. *c*). In the third stage, the dorsal spines on these segments are a little stouter but otherwise nearly the same as in the preceding stage; compare *b* and *d* and *c* and *e* of fig. 2. The varied form of some of the other spines are represented on plate 2, fig. 1., 2; see their explanation.

Description of the pupa. The dark mahogany brown pupa of this insect varies in length from one and one-half to nearly two inches. It is subcylindric in form, broadly rounded at the head, less so at its posterior extremity with its elongated bifurcate cremaster. The short wing-cases extend only to the fifth abdominal segment. The seven oval spiracles on each side are conspicuous. Regions of the head and cremaster, and the oval subdorsal areas on the first abdominal segment are tuberculate; the margins of the abdominal segments are usually minutely toothed. The larva pupates in an earthen cell, spinning no cocoon. The teeth on the segments and the long forked cremaster enable the pupa to work its way to the surface just before the moth is disclosed.

Description of the moth. This beautiful insect, with a wing-spread of from three and one-half inches in the male to nearly five or more in the female, ranks among the largest and most attractive of our native species. The purple brown markings on a yellow background are variable in depth of color and in extent. The following areas are purple brown in the female: patagia and the dorsum of the thorax lying between them; the dorsum of the anterior five abdominal segments except a median anterior spot on each; the basal fourth, the double dis-

cal spots with yellow centers and a more or less curved or oblique line, from the apex to its outer third, of the fore wings; an anal patch and a discal spot with an oblique line touching it on the hind wings. The yellow background is more or less spotted with dark brown, specially on the primaries. The males are readily indicated by their more feathery antennae and by the larger areas of purplish brown, specially on the fore-wings, where the basal patch extends to the discal spot, and frequently to the point where the oblique line touches the posterior margin of the wing. The larger portion of the area lying between this oblique line and the outer margin of the wing is purple brown, there being only a small yellow area within the posterior angle. The purple brown usually extends to the tip of the abdomen.

Two varieties of this insect have been described: *didyma* by Beauvois and *nobilis* by Neumoegen; the latter has also described an aberrant form under the name, *punctatissima* (see citation).

Distribution. The recorded distribution of this insect shows that it ranges over the greater portion of the United States and into Canada. Although nowhere very common, it appears to be more abundant in the latitude of southern New York and in Pennsylvania. In both Massachusetts and Canada it is reported to be very rare. It has been recorded from the following states: Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Kentucky, Illinois, Iowa, Texas; and from Belleville, Ontario. As it has been reported on cotton without giving the locality, it is probably known to occur in one or more of the cotton states. Morris gives the United States as its habitat.

Food-habits of the larva. This species has a very wide range of food-plants. Mr Beutenmüller (see citation) has published a list of them, comprising 49 species distributed through 12 orders. In addition, it has been found on three other species of plants belonging to as many orders not represented in the list referred to above, thus giving a total of 52 species representing 15 natural orders. Though found on so many plants, the white pine (*Pinus strobus*) appears to be its favorite in the north and species of oak in the south. Mr Gentry records (see citation) that in the vicinity of Germantown, Pa., the larvae of this insect appear to have deserted the pine for the red maple in the past few years. They also seem to have a liking for animal food. Mr Wailly (see citation) records an instance of cannibalism in the presence of abundant food, and also of this caterpillar feeding on the full grown larvae of *Telea polyphemus.*

Natural enemies. The larvae are said to be exceptionally free from parasitic attack. There is apparently no record of any true parasite having been reared from this species. Mr Siewers (see citation) records an instance where some confined in empty butter tubs were attacked by house ants, which ate nearly through the epidermis, but without fatal results, though the victims of the attack were covered with black spots.

An innoxious species. It is only exceptionally that this insect is abundant enough to do any material damage, and in consideration of the slight thinning of the foliage attacked by it, it will seldom, if ever be necessary to resort to spraying with the arsenites or to other means to keep it in check.

Lygus pratensis *Linn.*

Tarnished plant-bug

Ord. HEMIPTERA: Subord. HETEROPTERA: Fam. CAPSIDAE

Linnaeus, Carolus. Systema Naturae. Tom. 1, Pars 2, 12th ed., 1767. p. 728 (as *Cimax pratensis*).

Palisot de Beauvois, A. M. F. J. Insectes recueillis en Afrique et en Amérique dans les royaumes d'Oware. 1805–21. 20 (?) (as *Coreus linearis*).

Say, Thomas. N. Y. State agricultural society. Transactions. 1857. p. 784–85 (described as *Capsus oblineatus*); the same in Complete writings. LeConte ed. 1883. 1 : 340.

Harris, T. W. Insects injurious to vegetation. 3d ed. 1862. p. 200–3, fig. 85 (general account, as *Phytocoris lineolaris*).

Walsh, B. D. Practical entomologist. 1866. 1 : 77 (brief mention, as *Capsus oblineatus*).

Packard, A. S. Guide to the study of insects. 1869. p. 550 (mention, as *Phytocoris linearis*); Rocky Mt locust and other insects. Rep't. 1877. p. 732, 755, pl. 66, fig. 14 (on potato, cabbage, as *Lygus lineolaris*).

Walsh, B. D. & Riley, C. V. American entomologist. 1869. 1 : 227 (mention, as *Capsus oblineatus*).

Riley, C. V. Insects of Missouri. 2d Rep't. 1870. p. 113–15, fig. 83 (general account, as *Capsus oblineatus*); American entomologist and botanist. 1870. 2 : 276 (mention), p. 291–93, fig. 182 (general account, as *C. oblineatus*); Insects of Missouri. 7th Rep't. 1875. p. 26–27 (reference, as *C. oblineatus*); U. S. Dep't agriculture. Rep't. 1884. 1885. p. 312–15, pl. 4, fig. 3, 4 (extended account, as *Lygus lineolaris*); —— 1885. 1886. p. 317 (mention, as *L. lineolaris*); U. S. Dep't agriculture, Division entomology. Bulletin 31. 1893. p. 18, 24, 60 (attacking pear, strawberry, cabbage and cauliflower)

Saunders, William. Canadian entomologist. 1870. 2 : 111–12, 126 (injuring pears, as *Phytocoris lineatus*); Insects injurious to fruits. 1883. 1889. p. 147–48, 426 (general account, as *L. lineolaris*).

Glover, Townsend. Commissioner agriculture. Rep't. 1875. p. 126, fig. 34; Manuscript notes from my journal. 1876. p. 46 (brief accounts as *L. lineolaris*).

Lintner, J. A. Country gentleman. 1875. 40: 472 (on potato leaves, as *L. lineolaris*); Insects of New York. 1st Rep't. 1882. p. 279, 280, 331 (mention, as *L. lineolaris*); Canadian entomologist. 1884. 16: 182 (injuring peas, as *L. lineolaris*); the same in Entomological society of Ontario. 15th Rep't. 1885. p. 13; N. Y. State museum. 39th Rep't. 1887. p. 110 (on pear, as *L. lineolaris*); Insects of New York. 5th Rep't. 1889. p. 275, 326, fig. 43 (attacking pears); —— 6th Rep't. 1890. p. 189 (on tobacco); Country gentleman. 1891. 56: 577 (injuring beets); Insects of New York. 8th Rep't. 1893. p. 125 (on pear), p. 285 (mention), p. 291 (on potato leaves); —— 9th Rep't. 1893. p. 375 (injuring beets); —— 11th Rep't. 1896. p. 270 (on apple).

Cook, A. J. Cultivator and country gentleman. 1876. 46: 535 (brief account, as *Capsus oblineatus*).

Thomas, Cyrus. Ill. State horticultural society. Transactions. 1877. 1878. p. 175–76 (brief account, as *L. lineolaris*).

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Forbes, S. A. Insects of Illinois. 12th Rep't. 1883. p. 104 (on corn); —— 13th Rep't. 1884. p. 10, 62, 115–35, 138, pl. 11, 12, 13 (extended account); Wis. State horticultural society. Transactions. v. 13. 1884. Separate. p. 21–25, fig. 10–14 (general account); Insects of Illinois. 14th Rep't. 1885. p. 79–80, pl. 7, fig. 2; pl. 8 (life history, all as *Lygus lineolaris*).

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Uhler, P. R. Check list of the hemiptera heteroptera of North America. 1886. p. 18, no. 881 (synonymy).

Van Duzee, E. P. Canadian entomologist. 1887. 19: 71 (listed); Psyche. 1889. 5: 240 (mention); Buffalo society of natural sciences. Bulletin no. 4. 1894. 5: 177 (listed); Canadian entomologist. 1889. 21: 3 (from Muskoka lake district).

Comstock, J. H. Introduction to entomology. 1888. p 206–7 (brief account).

Riley, C. V. & Howard, L. O. Insect life. 1889. 2: 49–50 (on pear and apple), p. 255 (injuring salsify); —— 1891. 3: 364 (mention); —— 1894. 6: 211 (mention).

Garman, Harrison. Ky. agricultural experiment station. 3d Rep't. 1890. 1894 (Bulletin 31). p. 171–72, fig. 8 (brief account, on strawberries).

Jack, J: G. Garden and forest. 1890. 3 : 439 (injuring chrysanthemums, as *Lygus lineolaris*).

Murtfeldt, M. E. U. S. Dep't agriculture, Division entomology. Bulletin 22. 1890. p. 75 (on chrysanthemums, injuring apple and pear buds, strawberries).

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Bruner, Lawrence. U. S Dep't agriculture, Division entomology. Bulletin 23. 1891. p. 16 (on beet); Nebr. State board agriculture. Rep't. 1893. p. 447, fig. 78 (injuring small grains); Nebr. State horticultural society. Rep't. 1894. p. 162 (listed).

Osborn, Herbert & Gossard, H. A. Iowa agricultural experiment station. Bulletin 15. 1891. p. 270 (injuring beets).

Summers, H. E. Tenn. Agricultural experiment station. Bulletin 3. v. 4. ,1891. p. 90-91 (brief mention).

Townsend, C. H. T. Entomological society of Washington. Proceedings. 1891. 2 : 54 (in Mich.).

Weed, C. M. Insects and insecticides. 1891. p. 93-94, fig. 40 (brief account)

Cockerell, T. D. A. Canadian entomologist. 1892. 24 : 193 (on alfalfa. N. Mex.); Insect life. 1894. 7 : 210 (in the Mesilla valley); N. Mex. Agricultural experiment station. Bulletin 15. 1895. p. 66, 71 (taken in June, July).

Kellogg, V. L. Common injurious insects of Kansas. 1892. p. 80-81, fig. 44 (brief account, as *Lygus lineolaris*).

Davis, G. C. Mich. Agricultural experiment station. Bulletin 102. 1893. p. 10-13, fig. 6 (general account, on celery).

Fletcher, James. Entomological society of Ontario. 23d Rep't. 1893. 1894. p. 26-27, fig. 20 (brief account); —— 24th Rep't. 1894. 10, fig. 3 (abundant and injurious).

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As may be seen from the above somewhat extended, though incomplete bibliography, this insect has been frequently noticed by our writers

on economic entomology, during the past 30 years. It was first brought to their notice in 1831, by Say, who believing it to be an undescribed species, characterized it and gave it the name of *Capsus oblineatus*, stating that it was a very common insect. Later it was found that it had been previously described by Beauvois as *Coreus linearis*, and finally it was ascertained that it was originally described by Linnaeus, over 100 years ago, as *Cimex pratensis*.

Economic aspect. This insect has long been known as occurring on, and often quite injurious to a large number of both cultivated and native plants. Its earliest notice as of economic importance is by Harris, who represents it as a very general feeder. Another early account is that by Prof. Riley in his second report (see citation), where he ascribes to it an extended range of food plants, and mentions it as often exceedingly destructive to young pear trees. He cites the case of Mr E. J. Ayres of Villa Ridge, who, in his efforts to grow young pear trees, was quite discouraged by the insidious work of this insect. Prof. Riley also gives an instance, coming under his personal observation, of potato fields with almost every stalk blighted and black from the work of this pest. It has proved itself a destructive enemy of the strawberry, sucking the green berries and causing them to 'button' (Forbes, see citation). It has been recorded by a number of writers as very injurious to several flowers, and has recently been found injuring celery to such an extent as to materially reduce its market value. It is known to attack such a large number of plants that a list of them would be of little válue, including as it would, most of the crops grown on a farm and in the garden besides many native wild plants.

Injuries in peach nurseries. In a number of nurseries in the western part of this state, many peach-trees showed, in the early autumn of the present year, a peculiar short bushy growth, which was evidently caused by a blighting or stunting of the growing tips earlier in the year. In some localities, a large proportion, perhaps one half, of the young trees were so seriously affected as to greatly reduce their value, as they were no longer first-class stock. The damage to one block of trees, not many miles from Rochester, from this cause, was estimated by its owner at $1,000. The total loss for the year to the nurserymen growing peach-trees in that portion of the state, must have amounted to a number of thousands of dollars.

The nurserymen informed me that the trouble was due to an insect 'stinging' the young shoots from the bud as they appeared. The injury

to the growing twigs arrested their growth, and caused the young trees to throw out additional side shoots. In many instances these shoots would also be attacked and the tree, as the result, would develop a thick head of stubby branches. Many of these stunted and deformed trees were cut back and allowed to start again before they were sold.

At the time of my visit (August), it was too late to identify positively the author of the injury, as most of the damage had been inflicted early in the spring. An examination, however, showed the presence of the tarnished plant-bug, on the trees. A grower informed me that Prof. Slingerland, of the Cornell agricultural experiment station, had been studying the work of the insect a year or two before. On communicating with him, my suspicion as to the cause of the injury was confirmed, he having found their eggs in blighted tips and watched their oviposition in breeding cages.

Description. The following description of the immature stages of this insect is compiled from the notices of it by Prof. Forbes.

The egg. The smooth, pale watery-yellow egg of this species is slender, cylindric, slightly curved, round at one end, truncate and compressed at the other, .92 mm long and .25 mm wide at its greater diameter.

The single example from which the above description was drawn, was loosely placed among the hairs on the petiole of a dead leaf. According to Prof. Slingerland's observations, the eggs were evidently deposited within the young stems of peach trees.

The first stage. The recently emerged bug is a pale green or sulfur-yellow color with a median orange spot on the third abdominal segment, and about $\frac{1}{20}$ inch long. The antennae are nearly as long as the body, the beak extends to the last abdominal segment. Head slightly darker before the eyes, legs long, white, with an orange ring at the upper end of the tibiae. In the latter part of this stage the antennae, tarsi and apical segment of the beak become dusky, and a transverse black mark is seen just behind the orange spot on the abdomen. The tiny insect is sparsely covered with short black hairs.

The second stage. After the first molt it is $\frac{1}{12}$ inch long, the abdomen is broader than the thorax, a circular black spot occurs on each side of the middle of the first and second thoracic segments, and a median black quadrate spot on the suture between the third and fourth abdominal segments. The legs are much as before, except that the tibial rings are more brightly colored and there are traces of a second reddish tibial ring and of two femoral rings. The antennae are relatively shorter and darker, being reddish dusky with pale articulations, except that the second segment has a paler shade in the middle, and the basal one is nearly white.

The third stage. The greatest change after the second molt is in size, the insect being $\frac{11}{100}$ or $\frac{12}{100}$ inch long, the wing pads are just beginning to appear, and there is a higher coloration. 'In the more strongly marked specimens, the head, abdomen, legs and antennae, are more or less deeply suffused with crimson, the head having a median longitudinal

red stripe, with two short oblique ones on each side. The thorax is dusky, marbled with paler, with a median white line, and pale spaces surrounding the four black spots, and is sometimes variegated with crimson. The under side of the head and the tip of the abdomen beneath are also marked with crimson.'

The fourth stage. This stage is indicated by the much greater development of the wing pads, they being nearly half the length of the abdomen, and by the relatively much greater breadth of the insect. The antennae are less distinctly ringed; there are now four longitudinal dusky or crimson lines on the prothorax parallel with its margins; the wing pads are irregularly marked with fuscous; the abdominal sutures are crimson, with a crimson band across each segment. Some individuals are a uniform green above. The insect in this stage is quite variable in its markings.

With the fourth molt the adult form is assumed. The following description of the mature insect is given by Prof. Riley in his second report (see citation):

This bug is a quite variable species, the males being generally much darker than the females. The more common color of the dried cabinet specimens is a dirty yellow, variegated as in the figure with black and dark brown, and one of the most characteristic marks is a yellow V, sometimes looking more like a Y, or indicated by three simple dots, on the scutel, (the little triangular piece on the middle of the back, behind the thorax). The color of the living specimens is much fresher, and frequently inclines to olive green. The thorax, which is finely punctured, is always finely bordered and divided down the middle with yellow, and each of the divisions contains two broader longitudinal yellow lines, very frequently obsolete behind. The thighs always have two dark bands or rings near their tips.

Fig. 1 Tarnished plant-bug, LYGUS PRATENSIS (after Riley).

Life history and habits. The winter is passed by the mature insects in a dormant condition beneath any convenient shelter. They appear with the first indications of growth in the spring and may be found drawing their nutriment from the unfolding buds. Eggs are soon deposited on or in the stems of their food-plants, and the young emerging therefrom feed upon the more tender growth. Some of the earlier individuals mature by the middle of May or first of June in this latitude. From this time till September, young in all stages and adults may be found on the plants. This renders it difficult to determine the precise number of broods each year, but there are at least two in the state of New York.

This insect is very shy, as shown by the mature insects taking wing and the young dropping to the ground on the least alarm, or else moving quickly to the opposite side of the stem or leaf-stalk when approached. On cool mornings and evenings the insects are said to be rather sluggish,

and are then more easily captured while lying in concealment within the folds of the leaves.

Distribution. This insect has a very extended distribution, being found in all the states, north, south, east and west, and, according to Riley, extending south into Mexico. It also ranges north for some distance into British America, as Say received it from the 'Northwest Territory,' while Saunders, Fletcher and Van Duzee record it from various parts of Ontario.

Nursery protection. Owing to the very general feeding habits of this insect, it is difficult to indicate a satisfactory method for controlling it. In a general way much may be accomplished by burning its shelters in weeds and under rubbish late in the autumn or early in the spring.

As a protection against its injuries to young peach-trees, as noticed in a preceding page, it would be well if the ground selected for the nurseries were not surrounded by uncared-for land which would naturally offer shelter to the insect favorable to its multiplication and distribution.

When the insects are seen in the early spring to be unusually abundant in a nursery, their injury to the young stock should at once be arrested by jarring them from the trees, either into a large insect net or else into some modification of the umbrella used by collectors when beating insects from trees and shrubbery. A good form would be one similar to that recommended by Prof. Smith, reduced in size. Construct a light wooden frame about $2\frac{1}{2}$ feet square, with wires from the corners to a small central ring, which should be at least 10 inches lower than the frame. Fasten to the frame and inclose the wires with a light cloth (oil cloth would be preferable) in such a manner that insects dropping upon it would roll toward the center, and be caught in a small pail or can, containing a little kerosene and water, fastened to the central ring. A short handle should be fastened to the frame for its convenient use in the nursery rows. The insects could be readily jarred into the bag as the operator passes between the trees. This should be done in the cooler hours of the day when they are comparatively sluggish and would drop at the slightest disturbance.

NOTES ON VARIOUS INSECTS

Pyralis costalis *Fabr.*

Clover-hay caterpillar

Numerous examples of the larvae of this insect, which were noticed in detail in my 11th report, p. 145–51, were brought to my office by Mr H. S. Ambler, of Chatham, N. Y. They were found swarming in the cow stable of Mr G: C. Herschart, North Hillsdale, April 8, having probably emerged from a mow of clover nearby. It is probable that their feeding place had been disturbed by the hay containing them being fed to the stock, as they were only about two-thirds grown and are not known to leave their food voluntarily except for pupation.

The larvae were placed in a cage and provided with grass, on which they fed readily, eating both green and dried blades. They manifested a gregarious habit in spinning their silken larval cases in close proximity to one another. So marked was this, that most of the larvae would usually be found in about one-fourth of the material in the cage. The places selected for their retreats rapidly became filled with frass and speedily molded on account of the gathering dampness. This gregarious habit is undoubtedly of benefit, as it renders their food moist and more palatable, since they dislike food containing no moisture and are apparently unable to thrive when it is perfectly dry.

Fig. 2 The clover-hay caterpillar and gold-fringe moth, PYRALIS COSTALIS: 1, 2, larva; 3, cocoon; 4, pupa; 5, 6, moth; 7, larva within the web (from Riley).

April 19 a number of the larvae molted for the last time and others were observed casting their skins as late as May 4. A month later the pretty moths began to appear, and continued to emerge from time to time for about two weeks. Since Prof. Webster obtained a second brood in Ohio from moths emerging in June, it seems most probable that the insect has normally two generations annually in this vicinity, the moths of the second appearing about the middle of August, the same as in Ohio.

Cecidomyia leguminicola *Lintn.*

Clover-seed midge

In August my attention was called to the ravages of the above-named pest by Mr C. W. Stuart, of Newark, N. Y. He informed me that the crop of clover seed on 25 acres of land was completely ruined by the larvae of this insect. The presence of this midge renders the growing of clover seed in that vicinity extremely hazardous, and in many seasons none can be obtained. It has also been injurious in many parts of the state of Ohio.

Anthrenus scrophulariae *Fabr.*

Carpet beetle

In my 11th report, p. 172–73, the attractiveness of the blossoms of rhubarb (*Rheum rhaponticum*) was placed on record. The flowers of a number of other plants which bloom at the time the beetles are abroad also draw them, and in some cases the more attractive ones might be used as lures to prevent their entering houses, or for their convenient destruction as in the instance given below.

FIG. 3 Carpet beetle, ANTHRENUS SCROPHULARIAE (after Riley).

Mr M. B. Coombs, of Utica, N. Y., writes of the attractiveness of the tulip for the carpet beetle, as follows: 'My sister has for several years kept a bed of single tulips for the purpose of drawing the beetles for conveniently destroying them. They seem to congregate almost entirely on the light-colored blossoms, the creamy or yellow shades specially. For about two weeks, with a pair of tweezers, she picked out from them from two to three dozen on windy or otherwise unfavorable days, and hundreds on quiet sunny days.'

Elaphidion villosum *Fabr.*

Oak pruner

Mr G: T. Lyman, of Bellport, Suffolk co., N. Y., informs me that this species was quite abundant in 1896, and that it attacked the English oak and Norway maple as well as the native species. Thomas Matthews & Sons, of Baltimore, Md., also made complaint of its working in recently transplanted trees about five inches in diameter. It was observed as very abundant on Gov. Morton's farm at Ellerslie, on July 8, in the maples, almost every tree passed in the driveway having a number of pruned twigs lying beneath it.

Cyllene pictus *Drury*

Hickory borer

It is not often that this beautiful insect is the cause of trouble within a dwelling house, though it might occasionally be introduced in its larval stage while within pieces of black walnut furniture. It was of interest, therefore, when examples of this beetle were received from Miss M. L. Williams, of Brooklyn, N. Y., under date of March 12, 1897, with the following statement: 'During the last week we have been quite troubled by these beetles. With doors and windows still closed we are at loss to know where they come from.'

In giving the identification of the beetle, it was suggested that they must have been brought into the house within some wood in which they were boring, probably in fire wood. In reply Miss Williams stated that the surmise was correct, as the beetles, soon after, had been seen emerging from some hickory logs, lying in the fireplace at the time, in which a number of open burrows were already to be seen.

The above occurrence is of interest as it adds one more to the list of insects that may be the occasion of trouble to the housewife. It would have been of interest could the locality where the infested hickory was cut have been ascertained, but this could not be learned. As a rule, this species is commonly more rare than the closely allied locust borer, *Cyllene robiniae*. Figures of *Cyllene pictus* in its different stages, together witha brief notice of it were given in the *8th report on the insects of New York*, 1893. p. 175–76.

Galerucella luteola *Müller*

Elm-leaf beetle

This very injurious insect has repeatedly been noticed in preceding reports, particularly in the 11th and 12th[a] of this series, in consideration of the severity of its ravages brought directly to my notice during its presence in Albany and vicinity. It has also aroused more interest on account of the development of three generations annually in this latitude, as recorded in the preceding report, while in northern New Jersey only one annual brood is assigned to it.

The following fragmentary observations are put on record as confirming those of the preceding year, and also as adding to our knowledge of the habits of this insect.

July 3, of the present year, the larvae of the first brood were observed descending the trunks of the trees in large numbers, and six days later

[a] *11th Rep't. Insects of New York.* 1896. p. 189-96;——*12th Rep't.* 1897. p. 253-64.

pupae were abundant. Having completed their transformations, August 10 the recently emerged beetles had seriously injured the tender leaves unfolding on trees that had been defoliated earlier by the first brood, while the second brood of larvae had begun their destructive work. September 8, they had completed their growth and many had transformed to pupae. The spraying operations conducted by the civic authorities at Albany against this pest prevented satisfactory observations later in the season. However, on visiting the neighboring city of Troy, a number of bright living pupae were found on the remarkably late date of November 16 in the protected hollow of a tree. This should be accepted as incontrovertible evidence of the occurrence of three generations annually in that city.

The slow but continued spread of this insect recorded in preceding reports, was shown the present year by the appearance of the insect in force on English elms in Washington park, Albany (in the central portion of the city), hitherto exempt from its attack. Another noticeable feature of the insect's presence was the marked injury to the American elms in portions of the city where the pest has been established for several years. They were not, as a rule, so badly affected as the English elms. The greater part of the foliage of the affected American elms was partly skeletonized and injured to the extent that it presented a yellowish, unhealthy appearance, though not many of the leaves dropped as in the case of the more seriously injured English elms.

Blissus leucopterus *Say*

Chinch-bug

This insect was discovered in the autumn of 1896 on the farm of J. N. Haswell, 1 mile to the southwest of the city of Watervliet, N. Y., in Hungarian grass and timothy. This year (1897) it appeared on the same farm, in timothy, but not in clover or any other crop. It was not very injurious so far as known.

Plant lice or aphididae

The present year has been remarkable for the abundance of various aphides or plant lice on many different plants. In some cases their injuries were very serious, in others, natural enemies prevented their becoming unduly abundant.

Pemphigus populi-transversus *Riley*. Attention was drawn to this interesting species by the characteristic galls it produced on the

leaves of cottonwood, *Populus monilifera*, in Washington park, Albany, N. Y. The petioles of many of the fallen leaves from these trees last year (1896) showed the peculiar galls of this insect with its nearly transverse opening for the escape of the winged plant lice. During the autumn of the present year the galls of this species were nearly as abundant as in the preceding season.

Chaitophorus species. A plant louse belonging to this genus, was generally present in numbers on the under surface of the leaves of the Norway maple, *Acer platanoides*, throughout this city, and was also reported from a number of other localities within the state. Several winged and a number of wingless viviparous females were found on a leaf — the latter commonly surrounded by a numerous progeny — the winged individuals being, probably, the primary parents of the colony. The groups of young were usually clustered along the veins of the leaf, specially of those at the base; occasionally groups would be found almost midway between two veins. A large amount of honeydew was excreted, which, when dripping upon the flagging beneath, would indicate the presence of the insects above. The honeydew was quite viscid, and when falling upon leaves underneath frequently dried in hard clear beads of considerable size. This severe drain upon the tree continued for several weeks, till arrested by the multiplication of the natural enemies of this aphid. One of the most active was the common ladybug, *Adalia bipunctata*, the larvae and pupae of which were abundant on infested trees. A larger species, *Anatis ocellata*, was associated with it. Syrphid larvae and the young of lace-wing flies, also preyed on this species.

Examples of this insect were submitted to the division of entomology at Washington, but they could not be referred to any described species. Dr Howard had received it during the past season from many localities in New England, where it had been reported so injurious as to occasion the fall of many of the infested leaves.

Callipterus ulmifolii *Monell.* This delicate species was unusually abundant on the under surface of the foliage of American elms. The honey-dew produced by these species covered the sidewalk beneath, and the surface of the leaves upon which it fell. This severe attack continued through July and during the greater part of August, when it was finally arrested by heavy rains, together with the aid of numerous coccinellid larvae. Numbers of these, actively engaged in their beneficial work, could be seen upon the lower limbs. Of a number of the larvae picked up near the base of a small tree, nearly all were identified as *Adalia bipunctata*.

Drepanosiphum acerifolii *Thos.* This beautiful species occurred quite commonly in small numbers on the tender leaves and growing tips of the silver or white maple, *Acer dasycarpum.* It was rarely sufficiently abundant to cause any material harm, and is mainly interesting on account of its beauty and comparative rarity.

Aphis mali *Fabr.* The apple-tree aphis was extremely abundant in many localities in the state, early in the season, but in most cases the ravages of this pest were checked by its natural enemies before any extensive damage was caused. In the nursery center of Rochester and vicinity, the unusual multiplication of this insect imposed a large amount of work on those starting young trees. In some instances it was found necessary to treat the young stock growing from grafts two or even three times with kerosene emulsion, whale oil soap solution or tobacco water in order to keep the pests under control. Most of the nurserymen found the dipping of the slender trees into a vessel of the insecticide an easier and more effective method than spraying.

Myzus cerasi *Fabr.* The cherry-tree aphis was reported as very injurious in several localities in the state, causing the leaves to curl and shrivel.

Myzus ribis *Linn.* The currant aphis was brought to notice early in June in several localities, through complaint made of its abundance on the leaves of currant bushes.

Rhopalosiphum species. An aphid was found June 14 thickly infesting some of the leaves and fruit of a plum-tree belonging to Mr H. A. Unger of East Greenbush, N. Y. They swarmed on the leaves and literally covered portions of the young fruit. Examples were sent to Washington for identification, where they were examined by Mr Pergande. He was unable to refer them to any known species, but thought that they might possibly be an undescribed species of *Rhopalosiphum.*

Thrips tabaci *Lind.*

The work of this insect, commonly known as the onion thrips, was observed in August last at Newark, N. Y. The leaves of the infested onions were badly blasted, and the crop, it was thought, would be reduced one third. This pest was also found on the lower leaves of an adjoining cabbage field, but not in very large numbers.

PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the entomologist during the year of 1897: 40 are named, giving title, place and time of publication, and a summary of contents.

Elm-leaf beetle. (Country gentleman. Jan. 7, 1897. 62:7, col. 4, 27 cm)[a]

Corrections to an article on this insect from a correspondent of this Journal, on p. 1,003 of the preceding volume, as for example: there is no such form of insect as 'the egg larva;' the eggs are not infinitesimal in size;' they are not placed on the ground with fine atoms of earth intervening, but upon the leaves of the tree; the grubs do not descend from the tree and hunt out the eggs in the soil for the purpose of covering them with a protective secretion, and afterwards ascend the tree; it is not true that only the larva that hatch out late in the season become beetles; the eggs (on the leaves) can not be destroyed by treating the soil at the base of the trees; bands of cotton about the tree trunks could not serve to prevent the grubs from ascending.

Two insects. (Country gentleman. Feb. 11, 1897. 62: 106, col. 4, 8 cm)

To an inquiry if the warble-fly of England is identical with our 'buffalo-fly,' and when it first appeared in England, answer is made, that the European warble-fly is *Hypoderma bovis* DeGeer, while that of the United States is *Hypoderma lineata* Villers. The European species was named about 150 years ago, and our species, till about 15 years ago, was regarded as identical with it. *H. lineata* is known to attack the buffalo in the west, but the so-called 'buffalo-fly' is the one commonly known as the 'horn-fly,' *Haematobia serrata* Rob.-Desv., first noticed in this country in 1886.

Potato bugs. (Country gentleman. Feb. 18, 1897. 62: 126, col. 3, 3 cm)

Plaster of paris is recommended as preferable to ashes for mixing with paris green before applying it to potato vines.

Carbon bisulfid for pea weevil.—A serious danger. (Farmer's advocate. March 15, 1897. 32: 130, col. 3, 10 cm)

The danger of igniting carbon bisulfid, as suggested in a previous number of '*The Advocate*,' for the destruction of pea weevils, is shown and the proper method of treatment is briefly given.

Probably the cheese-mite. (Country gentleman. March 18, 1897. 62: 217, col. 2–3, 26 cm)

A correspondent from Valatie, N. Y., reports that some hams are infested with quantities of 'animated dust.' They are most probably swarming with the cheese-mite, *Tyroglyphus siro* Linn., though it may be *T. longior* Gerv. Characters of the species and their prolifi-

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[a] The length of each article is given in centimeters, i. e. col. 4, 27 cm.

cacy noted. Their source in the above infestation can not be indicated: their manner of spreading is given. Cleanliness is the most efficient preventive. Fumigation with sulfur and washing with kerosene emulsion is recommended for infested rooms. The mites work superficially and the infested meat may be dipped in a weak aqueous solution of carbolic acid after the mites have been removed so far as possible.

Canker worms. (Country-gentleman. April 1, 1897. 62:248, col. 1, 2, 18 cm)

A correspondent from Spencerville, Ind., requests a remedy for an insect which has been injurious for the past three years, and causes the apple trees to appear as though the tops had been killed by fire. The insect is identified as most probably *Anisopteryx vernata* Peck, the spring canker worm, although it may be the fall canker worm, *Anisopteryx pometaria* Harris. The life history is briefly given, and banding trees or spraying with paris green is recommended.

Apple-tree borers. (Country gentleman. April 22, 1897. 62:307, col. 3, 18 cm)

In reply to an inquiry from Harrison, N. Y., of proper treatment for apple-tree borers, it is stated: the principal apple-tree borers are two— the 'round-headed,' *Saperda candida* Fabr., and the 'flat-headed,' *Chrysobothris femorata* Fabr.,—the former attacking the base of the tree and the latter the upper part of the trunk. Some information of the species is given, and the best methods for preventing their injuries by means of washes, paper bands about the trunk, and digging out the larvae. Where detailed information of habits, remedies, etc., of these pests may be found.

Grasshopper. (Country gentleman. April 29, 1897. 62:326, col. 3-4, 11 cm)

The two rows of eggs touching one another and overlapping in each row sent for name from Augusta county, Va., are those of the 'angular-winged katydid,' *Microcentrum retinervis* Burm., of the southern states. The eggs are described and the manner of their peculiar deposit (overlapping) given. Dr Riley's account of the insect and its oviposition is referred to. In one instance the eggs were placed on a shirt collar in a laundry instead of their usual place on a small twig of a tree.

Cow-horn fly. (Country gentleman. May 6, 1897. 62:350, col. 1-2, 17 cm)

To a request for a remedy for the attack of the above-named insect, known scientifically as *Haematobia serrata* Rob.-Desv., recommendation is made of breaking up the cow droppings to promote their rapid drying, in which the eggs are deposited, and treating the manure in the stables with lime. Kerosene emulsion applied with a spraying machine to the cattle is recommended. Other remedies are the application of coal tar and lard, pine tar and grease, tallow and carbolic acid, and dusting the animals with tobacco dust or the X. O. dust.

Elm and apple-tree pests. (Country gentleman. May 20, 1897. 62 : 390, col. 1–2, 13 cm)

Protection from the elm-leaf beetle is found in early spraying with paris green, while the larvae are young, or by killing them with hot water or otherwise as they come to the ground for pupation.

For preventing injury by the apple-tree borer, apply soft soap and soda to the trunk in June and July, or cut out the young grubs from beneath the bark.

Tent caterpillar. (Country gentleman. May 20, 1897. 62 : 390, col. 2, 9 cm)

Caterpillars inhabiting a web on an apple-tree received from a Monroe county correspondent are identified as *Clisiocampa americana* Harris.

May beetle. (Country gentleman. May 20, 1897. 62 : 390, col. 2, 10 cm)

The dying of the grass in spots on a lawn reported from Staten Island, N. Y., probably indicates the presence of white grubs. Their habits are given and kerosene emulsion recommended, which has been used very successfully at Washington.

Strawberries and indian corn. (Country gentleman. May 20, 1897. 62 : 394, col. 1–2, 20 cm)

Report is made of a worm feeding on the leaves, blossoms and fruit of the strawberry, and that another feeds on ears of green corn. The insect attacking the strawberries is most probably a cut-worm, and can be best fought by the use of poisoned baits. For the other, which is probably the cotton boll-worm, *Heliothis armiger* Hübn., hand picking is recommended.

Elm-tree beetle. (Country gentleman. May 27, 1897. 62 : 406, col. 3, 4 cm)

A Brooklyn, N. Y., correspondent is answered that the largest elms can be protected from the beetle by means of a suitable force pump and a sufficient length of hose carried up into the tree. The inquirer is directed to the park commissioners of Brooklyn, for the spraying desired, or for further information to the entomologist of Central park, New York.

Grasshoppers. (Country gentleman. June 10, 1897. 62 : 446, col. 1–2, 11 cm)

In reply to an inquiry how to protect a garden from grasshoppers at Highland Lake, Col., allowing domestic fowls to run in the garden is recommended. The value of a poisoned bran mash is stated and directions given for its preparation and use.

Apple woolly louse. (Country gentleman. June 10, 1897. 62 : 454, col. 2, 3—21 cm)

Examples of an insect from Ruxton, Md., are identified as the woolly louse of the apple, *Schizoneura lanigera* Hausm. The two forms of the insect are referred to, and their characteristics given.

The species is often very destructive in Europe where it is known as the American blight. The wide distribution of the insect is briefly stated. Kerosene emulsion, hot water, soap solution, tobacco water or dust, or bisulfid of carbon are the remedies advised.

Arsenic and animals. (Country gentleman. June 10, 1897. 62 : 454, col. 3, 5 cm)

Inquiry is made from Warren, Va., if the drippings from trees sprayed with arsenites would injure live stock feeding on the grass beneath. In reply it is stated that if the spraying is properly done neither the grass nor hay from such localities will be injurious.

Apple-tree aphis. (Country gentleman. June 17, 1897. 62 : 470, col. 1, 5 cm)

An aphis attack, sent from Watervliet, Mich., is that of *Aphis mali* Serious injury from this insect is usually prevented if heavy rains occur, as have recently fallen in New York and neighboring states.

Carpet beetles. (Country gentleman. June 17, 1897. 62 : 470, col. 2, 6 cm)

Insects sent from Poughkeepsie, N. Y., where they are infesting Spiraea, are the carpet beetle, *Anthrenus scrophulariae*, which are often found at this season abundantly on the flowers of several of the species of Spiraea, in addition to the one submitted, which is *S. rotundifolia.*

Grain weevil. (Country gentleman. June 24, 1897. 62 : 486, col. 2, 8 cm)

A correspondent from Nazareth, Pa., inquiring if any plant could be strewn among unthreshed grain to protect it from weevil, is answered that no such plant is known, but a French agricultural paper has stated that grain weevils could be attracted from a grain bin to a tub of aniseed, and soon killed after contact with it.

Wire-worms. (Country gentleman. June 24, 1897. 62 : 486, col. 2–3, 15 cm)

To an inquiry from Elmira, N. Y., for prevention of wire-worms in cabbage-roots, recommendation is made of carbon bisulfid poured in holes near the plants. Kerosene emulsion might drive them from the plants. Reference is made to notices of wire-worms in the *Country gentleman.*

Long-sting. (Country gentleman. July 1, 1897. 62 : 506, col. 3, 8 cm)

An insect received from Racket River, N. Y., found in a granary, is the 'black long-sting,' *Thalessa atrata* Fabr. Some of the characters of the insect, its general features, and the use of its long ovipositor are given.

Army-worm. (Country gentleman. July 1, 1897. 62 : 506, col. 4, 8 cm)

The fear that Hungarian grass seed may contain the eggs of the army-worm is groundless, nor is this grass known to be preferred for food by the larvae. A repetition of army-worm attack is not expected in the state of New York the present year. No good preventive of attack is known. Prompt destruction of the newly hatched larvae is the best remedy.

Honeydew. (Country gentleman. July 8, 1897. 62 : 526, col. 1, 6 cm)

Maple leaves are sent from Port Chester, N. Y., 'covered with gum.' The substance is identified as honeydew, probably exuded by plant-lice infesting the trees. Their unusal abundance is noted and remedies given.

Cherry-tree Myzus. (Country gentleman. July 8, 1897. 62 : 526, col. 2, 8 cm)

Twigs of cherry-trees from Yonkers, N. Y., show a severe attack of the plant-louse, *Myzus cerasi*. If not speedily arrested by its insect enemies, the infested tips should be sprayed upon their under side with whale-oil soap solution or tobacco water.

Scurfy bark louse. (Country gentleman. July 8, 1897. 62 : 526, col. 2–3, 10 cm)

An infestation of an apple-tree in Newark, N. J., which was supposed might possibly be the San José scale, is that of the scurfy bark louse, *Chionaspis furfurus* Fitch. Its range in the United States is given with note of its moderate multiplication. Remedies are: spraying with kerosene emulsion, or with tobacco water, or whale-oil soap solution, preferably when the young are hatching, or brushing with a stiff brush or a cloth saturated with the soap solution.

Plant lice. (Country gentleman. July 8, 1897. 62 : 526, col. 3, 9 cm)

Insects reported as injurious to grape-vines and other plants, are species of aphids or plant lice. Hellebore, kerosene emulsion or tobacco water are recommended for killing them. They will soon, probably, be attacked and destroyed by their natural enemies.

The San José scale. (Country gentleman. July 8, 1897. 62 : 533, col. 1–3, 97 cm)

A general article treating of the introduction and spread of *Aspidiotus perniciosus* in California; its discovery on the Atlantic coast; the infested localities in the eastern states; its distribution in New York; the appearance of the scale and its numerous food-plants; methods of distribution; the most approved remedies and the fungus, *Sphaerostilbe coccophila* Tul., which destroys it.

Elm-leaf beetle. (Argus [Albany]. July 10, 1897. p. 17, 39 cm)

Replying to a communication to the *Argus* relating to the destruction of the elms in Albany by insects, answer is made that the chief depredator is the elm-leaf beetle, *Galerucella luteola*. Its introduction

and spread in Albany is stated. Its ravages are mainly limited to the English elms. It may be largely controlled by proper spraying. The city authorities should undertake the work, and the proper spraying machine to be used for the purpose is indicated. The destruction of the European elms will inevitably follow unless this is promptly done.

Not the gypsy moth. (Country gentleman. July 15, 1897. 62:558, col. 1, 10 cm)

The presence of the gypsy moth in Delaware co., N. Y., and its serious ravages, have been reported by recent New York papers. From examples of the caterpillars received, they are found to be, as was suspected, the apple-tree tent caterpillar and the forest tent caterpillar.

Chinchbug. (Country gentleman. July 15, 1897. 62 : 558, col. 1–2, 30 cm)

Replying to inquiry from Salem, N. C., the following directions are given for preventing serious injury from the chinch bug; arresting marches by trenching or ditching; application of kerosene emulsion; burning over infested portions of fields, or the introduction of the chinch bug fungus, *Sporotrichum globuliferum.*

Subterranean grubs. (Country gentleman. Aug. 26, 1897. 62:666, col. 4, 12 cm)

Grubs, represented as having destroyed hundreds of California privet plants in a hedge at Ruxton, Md., are probably *Lachnosterna* sp. or *Allorhina nitida.* They should be treated with kerosene emulsion after the method employed in the capitol grounds in Washington some years ago.

San José scale. (Country gentleman. Aug. 26, 1897. 62 : 667, col. 1, 5 cm)

For the method of destroying this insect, reference is made to an article in the *Country gentleman* for July 8 of this year, p. 533.

Tussock moth. (Country gentleman. Sep. 2, 1897. 62 : 686, col. 2, 7 cm)

Caterpillars feeding on plum-trees at Moreton Farm, N. Y., are the hickory tussock moth, *Halisidota caryae* Harris. Their appearance and habits are given, and arsenical spraying recommended for their destruction.

Insects and fruit. (Country gentleman. Sep. 2, 1897. 62 : 686, col. 2, 8 cm)

Inquiry from Cohasset, Mass., for means of protecting peaches from injury by wasps and bees, is answered by suggesting their early picking for subsequent ripening, or inclosure of the trees by netting. A sweetened mixture for attracting the insects is suggested. Possibly the insects attack the fruit only after the skin has been broken by birds.

Urocerus albicornis. (Country gentleman. Sep. 9, 1897. 62: 707, col. 1, 10 cm)

This saw-fly was received from Carthage, N. Y., where it had been taken while ovipositing in newly sawn spruce lumber. Its principal features are given together with the manner of oviposition.

[See pages 338–40 of this report.]

Plague of flies. (Country gentleman. Oct. 14, 1897. 62: 806, 807, col. 4, 15 cm)

A dwelling house in Peekskill, N. Y., is infested with 'house flies,' although the stable is 1,500 feet distant, and 'armies' have been killed by fly-paper and traps. Recommendation is made of screens for windows and doors and trapping the few that would evade them. Possibly the fly may be the 'cluster-fly,' *Pollenia rudis*, which in certain localities has the habit of entering houses in the autumn for hibernation. Persian insect powder is most effectual for these.

Pine borer. (Country gentleman. Nov. 4, 1897. 62: 867, col. 2–3, 4 cm)

The operations of 'a large white grub' found in exuded masses of pitch on the lower limbs of a Scotch pine and causing the death of the foliage, are described, but without examples of the grubs the species can not be named. Its method of running its burrows, as given, and its living within the pitch, are quite interesting.

Pine borer. (Country gentleman. Nov. 11, 1897. 62: 887, col. 1, 11 cm)

From examples received, the caterpillars boring pines are identified as the larvae of *Harmonia pini* Kellicott, an insect closely related to the peach borer. It was described in 1881, and its operations in three counties of this state were observed by Dr Kellicott. A brief account of its life-history is given and comment made upon its peculiar boring habits. The question is raised whether the insect attacks only sickly trees.

Fall canker worm and its eggs. (Country gentleman. Dec. 16, 1897. 62: 986, col. 2–3, 29 cm)

A cluster of eggs on an apple-twig from Newton, Mass., submitted Nov. 27 for name and information respecting them are those of the fall canker-worm, *Anisopteryx pometaria* Harris. The eggs and the caterpillars are described. The eggs are deposited in November or later in warm days during the winter. They hatch in the spring when the trees begin to put forth their leaves, and are often found associated with the spring canker-worm, *Anisopteryx vernata* — which they closely resemble.

Spraying with the arsenites as soon as they are seen, is recommended.

CONTRIBUTIONS TO THE COLLECTION IN 1897

HYMENOPTERA

Chalybion caeruleum Linn. From J. A. OTTERSON, Berlin, Mass., Sep. 1.

Examples of *Lasius interjectus* Mayr. From J. V. D. WALKER, Jamaica, N. Y.

Black long-sting, *Thalessa atrata* Fabr. From W. R. STRONG, Golden's Bridge, N. Y., Sep. 9.

White-horned horn-tail, *Urocerus albicornis* Fabr., boring in spruce, at Carthage, N. Y. From W. H. COLEMAN, Albany, N. Y.

Dolerus arvensis Say, occurring abundantly on a tree, May 4. From CHARLES H. HARDIN, Schenectady, N. Y.

Saw-fly larvae of *Acordulecera dorsalis* Say, from oak, June 13. From HARRISON G. DYAR, Bellport, L. I.

LEPIDOPTERA

Chrysalis of *Grapta comma* Harris. From A. P. HALL, Albany, N. Y.

Thyreus abbotii Swainson, May 15. From W. H. COLEMAN, Albany, N. Y. A larva of the same, June 30, from M. TANNER, Albany, N. Y. A larva of the same, July 26, from S. M. DAVIES, Albany, N. Y. A larva of the same and of *Philampelus pandorus* Hübn., from J. N. GALLATIN, Litchfield, Ct.

Larva of the tomato worm, *Protoparce celeus* Hübn., Aug. 21. From Mrs E. B. SMITH, Coeymans, N. Y.

Pine-boring larvae, of *Harmonia pini* Kellicott, in pitch, Nov. 2. From C. H. ROBERTS, Ulster county, N. Y.

Larvae (3) of the eight-spotted forester, *Alypia octomaculata* Fabr., and the Virginia ermine moth, *Spilosoma virginica* Fabr. From Mrs GILMAN H. PERKINS, Rochester, N. Y.

Larva of *Empretia stimulea* Clem., on chestnut, Oct. 19. From Miss R. C. de V. CORNWELL, Scarsdale, N. Y.

Larva of *Nadata gibbosa* Sm.-Abb. found in a cell of *Eumenes fraterna*. From W. B. DUPREE, Brooklyn, N. Y., Sept. 28.

The Cecropia emperor moth, *Attacus cecropia* Linn., July 10. From GEORGE SELLNOW, Albany, N. Y.; also, from PHILIP SEEHAUS, Coeymans, N. Y.

Egg-belt of *Clisiocampa americana* Harris. From E. T. SCHOONMAKER, Cedar Hill, N. Y.

Larvae of *Clisiocampa disstria* Hübn., May 20. From L. B. WHEELER, Berlin, Mass. Larvae and pupae of the same, from H. B. INGRAM, Kingston, N. Y. Pupae of the same from Mrs W: W. Foster Pittsford Mills, Vt., and from S. B. CHAMPION, Stamford, N. Y., and from JOHN MICKLEBOROUGH, Jewett, Greene co., N. Y.

Carneades obeliscoides Guenée, *Leucania albilinea* Hübn. and *Plusia precationis* Guénee. From Mrs E. B. SMITH, Coeymans, N. Y.

Zebra cabbage moth, *Mamestra picta* Harris. From F. J. RIGGS, Albany, N. Y.

Examples of *Diastictis ribearia* Fitch, from currant, June 15. From Mrs H. D. GRAVES, Ausable Forks, N. Y.

Numerous examples of the clover-hay caterpillar, *Pyralis costalis* Fabr., from near a barn, April 8. From H. S. AMBLER, North Hillsdale, N. Y.

Larvae of the gartered plume-moth, *Oxyptilus periscelidactylus* Fitch, May 27. From C: A. OTTERSON, Berlin, Mass.

Pea-moth, *Laspeyresia nigricana* Steph. From JAMES FLETCHER, Ottawa, Canada.

DIPTERA

Sciara vulgaris Fitch, four examples. From W. D. BARROWS, Agricultural college, Mich.

Sciara prolifica Felt., numerous examples. From J: A. OTTERSON, Berlin, Mass.

Large black horse-fly, *Tabanus atratus* Fabr. From Mrs GILMAN, H. PERKINS, Rochester, N. Y.

Eggs and larvae of *Tabanus reinwardtii* Wied. From J: A. OTTERSON, Berlin, Mass.

Therioplectes cinctus Fabr. From J: A. OTTERSON, Berlin, Mass.

Pupae of *Eristalis tenax* Linn., July 20. From Mrs J. H. DANFORTH, Mayfield, N. Y.

Larvae of the emasculating bot-fly, *Cuterebra emasculator* Fitch, Aug. 16. From W: S. ABERT, Saranac Inn, Franklin co., N. Y.

Examples of *Stomoxys calcitrans* Linn. From J: A. OTTERSON, Berlin, Mass.

Cat flea, *Ceratopsyllus serraticeps* Gerv. From Dr S. G. SHANKS, Albany, N. Y.

Coleoptera

Necrophorus americanus Oliv. From J: A. Otterson, Berlin, Mass., Sep. 1.

15-spotted lady-bird, *Anatis ocellata* Linn. From J: A. Otterson, Berlin, Mass. Sep. 1.

Saw-toothed grain weevil, *Silvanus surinamensis* Linn., in linseed meal. From F. J. Riggs, Albany, N. Y.

Limonius confusus LeConte, from blossoms of a quince tree, May 18. From L. B. Shaffer, Albany, N. Y.

Virginia Buprestid, *Chalcophora virginiensis* Drury. From George R. Howell, Albany, N. Y.

Photuris pennsylvanica De Geer. From J: A. Otterson, Berlin, Mass., Sep. 1.

Numerous examples of *Sitodrepa panicea* Linn. From Charles Griffen, New York city.

Aphodius fimetarius Linn. From J: A. Otterson, Berlin, Mass.

Light-loving grape-vine beetle, *Anomala lucicola* Fabr. From J: A. Otterson, Berlin, Mass., Sep. 1.

Spotted grape-vine beetle, *Pelidnota punctata* Linn. From A. H. Stratton, Arlington, N. J.

Osmoderma scabra Beauv. From Mrs E. B. Smith, Coeymans, N. Y.

Prionus laticollis Drury. From J: A. Otterson, Berlin, Mass., Sep. 1.

Callidium antennatum Newm. From R. L. Banks, Albany, N. Y.

Elaphidion villosum Fabr. From Mrs E. B. Smith, Coeymans, N. Y.

Hickory borer, *Cyllene pictus* Drury, 2 examples. From Miss M. L. Williams, Brooklyn, N. Y.

Asparagus beetle, *Crioceris asparagi* Linn. From Julius G. Linsley, Oswego, N. Y.

12-spotted Diabrotica, *Diabrotica 12-punctata* Oliv. From J: A. Otterson, Berlin, Mass., Sep. 1.

Larvae, pupae and imagoes of the elm-leaf beetle, *Galerucella luteola* Müller. From S. C. Bradt, Albany, N. Y. Imagoes of the same, taken from flour, July 14, from Henry Russell, Albany, N. Y.

Oedionychis thoracica Fabr. From J: A. Otterson, Berlin, Mass., Sep. 1.

Cucumber flea-beetle, *Epitrix cucumeris* Harris, on tomato. From F. J. Riggs, Albany, N. Y.

Examples of *Systena hudsonias* Forst., on apple. From V. H. Lowe, Geneva, N. Y.

Odontota dorsalis Thunb., four examples, from locust-tree, Aug. 31. From H. G. DYAR, Bellport, L. I.

Clubbed tortoise-beetle, *Coptoccyla clavata* Fabr. From GEORGE B. SIMPSON, Albany, N. Y.

Examples of *Epicauta pennsylvanica* De Geer, on Clematis. From Mrs J. C. MILLER, Alder Creek, N. Y.

Larvae and imago of a snout-beetle, *Otiorhynchus sulcatus* Fabr., injuring strawberry plants. From Mrs GILMAN H. PERKINS, Rochester, N. Y.

Calandra oryzae Linn., infesting rice and macaroni. From BOWERS & SANDS, New York.

HEMIPTERA

Podisus modestus Dallas, *Euschistus fissilis* Uhler. From J: A. OTTERSON, Berlin, Mass.

Eggs (hundreds) of the squash-bug, *Anasa tristis* De Geer, July 19. From F. J. RIGGS, Albany, N. Y. Eggs and imagoes of the same, from Mrs F. L. GOODENOUGH, Windsor, N. Y., July 23.

Chinch bug, *Blissus leucopterus* Say. From J. N. HASWELL, near Watervliet, N. Y.

Young of the bed bug hunter, *Opsicoetus personatus* Linn. From Mrs E. C. ANTHONY, Gouverneur, N. Y.

Emesa longipes De Geer and the dog-day Cicada, *Cicada tibicen* Linn. From Mrs E. B. SMITH, Coeymans, N. Y.

Schizoneura rileyi Thomas. From G: R. HANFORD, Watertown, N. Y.

Lecanium hesperidum Linn., on house fern. From S. C. BRADT, Albany, N. Y.

Lecanium tulipiferae Cook, on the tulip-tree. From Miss S. G. TOMPKINS, Somers, N. Y.

San José scale, *Aspidiotus perniciosus* Comstock, on apple and pear. From A. W. K. DICK, Germantown, N. Y. The same, on pear and currant, from H. A. UNGER, East Greenbush, N. Y.

Apple-tree bark louse, *Mytilaspis pomorum* Bouché, abounding on a poplar. From ADDISON KEYES, Berlin, Mass. The same, on poplar, from Miss C. A. SMITH, Springfield, Mass. The same, on balm-of-Gilead, from E. T. SCHOONMAKER, Cedar Hill, N. Y. The same, on *Magnolia umbrella*, from JESSIE ELTING, New Paltz, N. Y.

Scurfy bark louse, *Chionaspis furfurus* Fitch. From ABEL DANCE, New York city.

Orthoptera

Periplaneta orientalis Linn. From Joseph Karr, Troy, N. Y.

Nyctobora ?holosericea Klug. From Mrs G: B. Thompson, Albany, N. Y.

Neuroptera

Plathemis trimaculata De Geer, from North Elba, N. Y. From Charles Mills, Fairmount, N. Y. Also from J: A. Otterson, Berlin, Mass.

Examples of Phryganidae, species undetermined. From Prof. Charles H. Peck, Albany, N. Y.

Thysanura

Lepisma sp. From Mrs M. E. Horne, Maynard, N. Y.

Arachnida

Clover mite, *Bryobia pratensis* Garman, infesting a house. From Edwin H. Stanford, Camden, N. Y.

Cattle tick, *Boöphilus bovis* Riley. From J. D. Skidmore, East Hampton, N. Y.

Myriapoda

Scutigera forceps Raf. From S. M. Davies, Albany, N. Y.

Numerous examples of *Leptodesmus falcatus* Lintn., from garden soil. From Miss M. L. Brown, Albany, N. Y.

EXPLANATION OF PLATES

Plate 1

Fig. 1 Tenthredo rufopectus.

Fig. 2 Janus integer.

Fig. 3 Urocerus albicornis.

Fig. 4 Urocerus flavicornis.

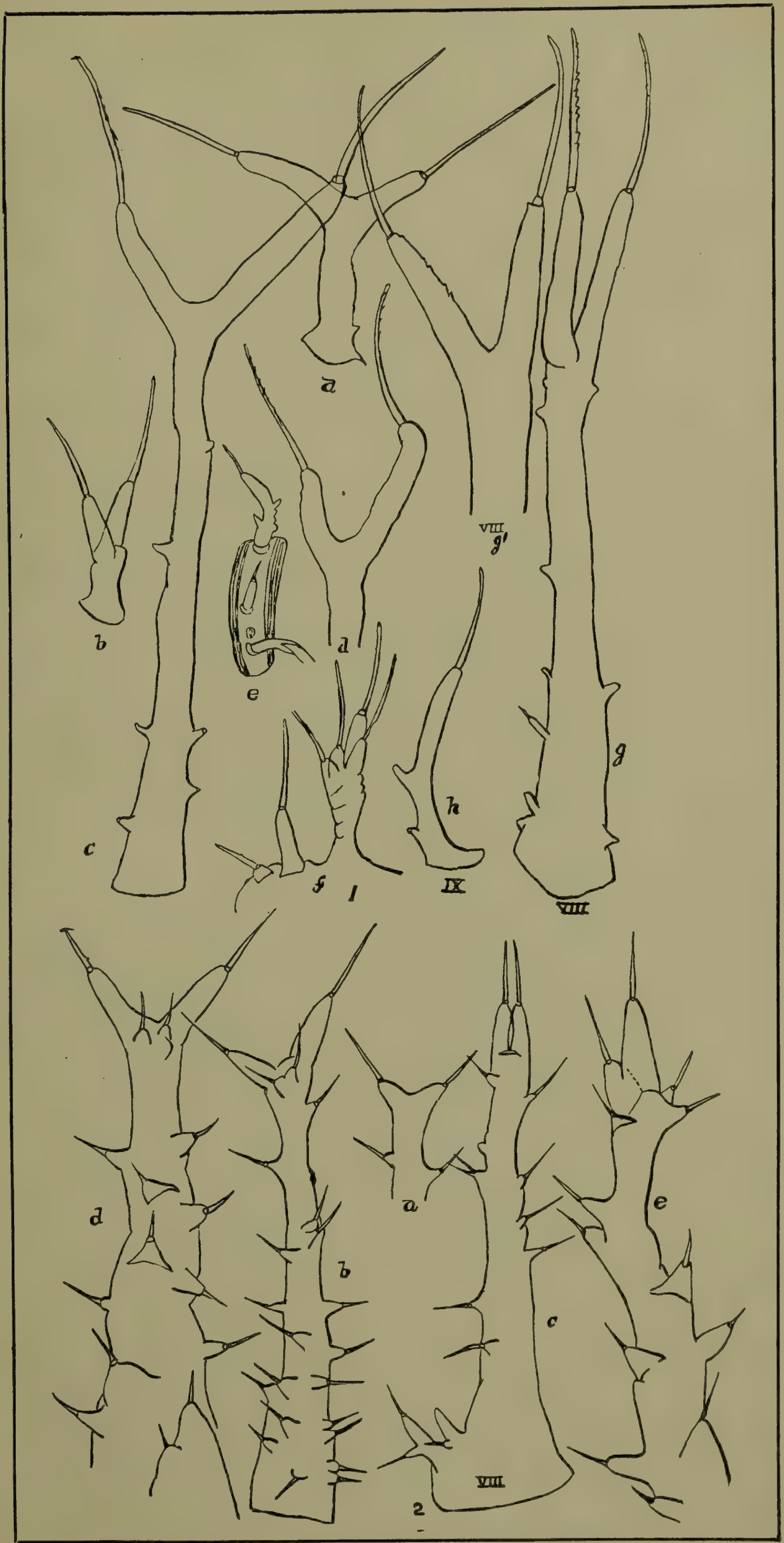
Plate 2

Fig. 1 Stage 1: *a*, *c*, *d*, dorsal spines of first, second, third, thoracic segments; *b*, subdorsal spine of first thoracic segment, *e*, first abdominal segment showing dark bands, spines and spiracle; *f*, subanal plate in part, showing spines; *g*, dorsal spine or horn of eighth abdominal segment seen partly from the side; *g'*, end of same; *h*, dorsal spine on ninth abdominal segment (after Packard).

Fig. 2 Stage 2: *a*, *b*, dorsal spines of first and second thoracic segments; *c*, spine or horn of eighth abdominal segment. Stage 3: *d*, spine of second thoracic segment; *e*, the same of eighth abdominal segment (after Packard).

Plate 1

Horn-tails and two currant borers.



Armature of Eacles imperialis (after Packard).

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GENERAL INDEX

r prefixed to the page numbers refers to the Director's report; other page numbers refer to the appendixes. The superior figures tell the exact place on the page in ninths; e. g. 23^{3} means page 23, beginning in the third ninth of the page, i. e. about one third of the way down.

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